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Long-Term Effects of Land Application of Domestic Wastewater: Tooele, Utah, Slow Rate Site. Volume 1: Field Investigation

Utah Water Research Lab, Logan

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Robert S Kerr Environmental Research Lab, Ada, OK

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Long-Term Effects of Land Application of Domestic Wastewater: Tooele, Utah, Slow Rate Site

Volume 1: Field Investigation

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The treated municipal effluent applied as irrigation water to the treated site was of a significantly poorer quality than the normal irrigation water applied to the control site. The treated effluent mean biochemical oxygen demand (BOD_5) concentration was 14.1 mg/l in 1976 and 16.0 mg/l in 1977 compared to a mean BOD_5 concentration of 1.6 mg/l in 1976 and 2.5 mg/l in 1977 of irrigation water applied to the control site. The treated municipal effluent was higher in nutrients and heavy metals concentrations than the control site water. However, neither the treated site nor control site was irrigated with water of poorer quality than recommended irrigation water quality criteria.

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LONG-TERM EFFECTS OF LAND APPLICATION OF DOMESTIC WASTEWATER: TOOELE, UTAH, SLOW-RATE SITE

Volume I: Field Investigation

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FOREWORD

The Environmental Protection Agency was established to coordinate the administration of major Federal programs designed to protect the quality of our environment.

An important part of the agency's effort involves the search for information about environmental problems, management techniques, and new technologies through which optimum use of the nation's land and water resources can be assured and the threat pollution poses to the welfare of the American people can be minimized.

EPA's Office of Research and Development conducts this search through a nationwide network of research facilities. As one of these facilities, the Robert S. Kerr Environmental Research Laboratory is responsible for the management of programs including the development and demonstration of soil and other natural systems for the treatment and management of municipal wastewaters.

Although land application of municipal wastewaters has been practiced for years, there has been a growing and widespread interest in this practice in recent years. The use of land application received major impetus with the passage of the 1972 amendments to the Federal Water Pollution Control Act. The 1977 amendments to the Act gave further encouragement to the use of land application and provided certain incentives for the funding of these systems through the construction grants program. With the widespread implementation of land application systems, there is an urgent need for answers to several major questions. One of these questions regards the long-term effects of land application on the soil, crops, groundwater, and other environmental components. This report is one in a series of ten which documents the effects of long-term wastewater application at selected irrigation and rapid infiltration study sites. These case studies should provide new insight into the long-term effects of land application of municipal wastewaters.

This report contributes to the knowledge which is essential for the EPA to meet the requirements of environmental laws and enforce pollution control standards which are reasonable, cost effective, and provide adequate protection for the American public.

William C. Galegar

William C. Galegar
Director
Robert S. Kerr Environmental Research Laboratory

ABSTRACT

Application of wastewater to the land has been designated a viable alternative for wastewater treatment by the Water Pollution Act Amendments of 1972 (PL 92-500). However, very little information is available concerning the long-term effects of applying wastewater to the land. The general objective of this study was to determine the long-term effects of employing secondary treated municipal wastewater as irrigation water. The study compared the quality of soils, crops, groundwater, and applied water to a site receiving normal irrigation water (control site) to a site (treated site) which had utilized secondary treated municipal effluent for irrigation water during a 20-year period. Similar management practices were employed at both sites.

The treated municipal effluent applied as irrigation water to the treated site was of a significantly poorer quality than the normal irrigation water applied to the control site. The treated effluent mean biochemical oxygen demand (BOD_5) concentration was 14.1 mg/l in 1976 and 16.0 mg/l in 1977 compared to a mean biochemical oxygen demand (BOD_5) concentration of 1.6 mg/l in 1976 and 2.5 mg/l in 1977 of irrigation water applied to the control site. The treated municipal effluent was higher in nutrients and heavy metals concentrations than the control site water. However, neither the treated site nor control site was irrigated with water of poorer quality than recommended irrigation water quality criteria.

The treated site has been irrigated with secondary treated municipal effluent since 1957, however, soils analysis indicated no accumulation of nitrogen, lead, zinc, copper, chromium, nickel, or soluble salts as a result of the effluent application. Available phosphorus was the only soil parameter which appeared in greater quantities in the treated site compared to the control site. The soils investigation in this study cannot provide any negative aspects to the long-term use of secondary treated municipal effluent for irrigation.

Economic plant cultivars, representing forage, root and seed crops, were grown on the treated site and control site to determine the effects of long-term irrigation with treated effluent on crop characteristics. Data were recorded on growth rate, fresh and dry weights, percent moisture, yield, cadmium, calcium, copper, iron, lead, nitrogen, phosphorus, potassium, sodium and zinc. With few exceptions, all crops exhibited increased plant height and yield when grown on the treated site. Generally, more variation was observed between years than between treatments for most of the crops used in the experiments. Chemical analyses of the edible plant portion generally indicated less copper, iron and zinc, but more sodium in those plants growing on the treated site than on the control site. These data (physical and chemical responses)

suggest that it is sufficiently safe to produce edible crops on land to which sewage effluents have been applied. However, no bacteriological or virus analyses were performed to determine pathogenic effects.

This report was submitted in fulfillment of Contract No. 68-03-2360 by Utah State University under the partial sponsorship of the U. S. Environmental Protection Agency. This report covers a period from January, 1976, to June, 1978, and work was completed as of December, 1978.

CONTENTS

Foreword iii
Abstract iv
Figures viii
Tables xi
List of Abbreviations and Symbols xxi
Acknowledgments xxii

1. Introduction 1
    Nature of the Problem 1
    Objectives 1
    Scope 2
2. Conclusions 3
3. Recommendations 6
4. Methods 7
    General 7
    Site Selection 8
    Site Description 9
    Water Quality and Quantity 16
    Soil Sampling 22
    Plants 26
5. Results of Water Quality and Soil Investigation 36
    Physical Description of Site 36
    Water Quality 37
    Soil Characteristics 55
6. Results of Plant Investigations 90
    Introduction 90
    Water Quality 91
    Plant Results From Garden Plots 93
    Implications For Long Term Effects 143

References 161
Appendices
    A. Soil Investigation 165
    B. Water Quality Data 178
    C. Statistical Comparison of the 1976 Water Quality Data With the 1977 Water Quality Data 273

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FIGURES

Number		Page
1	Location map	12
2	Schematic of treated site	13
3	Schematic of control site	15
4	Location of surface water and soil sample stations	17
5	Location of soil sampling stations for determining the chemical properties of soil at the treated site	23
6	Location of soil sampling station for determining the chemical properties of soil at the control site	24
7	Garden plot at treated site (randomized block design), 1976	29
8	Garden plot at control site (randomized block design), 1976	30
9	Garden plot at treated site (randomized block design), 1977	31
10	Garden plot at control site (randomized block design), 1977	32
11	The NH_4-N content in control and treated site soils collected in June 1976 and in September 1976	67
12	The NO_3-N content in control and treated site soils collected in June 1976 and September 1976	68
13	The total Kjeldahl nitrogen in soils from control and treated site sampled September 1976 and June 1977 . . .	72
14	Sodium bicarbonate-soluble phosphorus extracted from the soils in the control and treated site (sampled June 1976)	74
15	Influence of sewage effluent on first growth of alfalfa, 1976	94

FIGURES (CONTINUED)

Number Page

16 Influence of sewage effluent on first growth of alfalfa, 1977 95

17 Influence of sewage effluent on second growth of alfalfa, 1976 99

18 Influence of sewage effluent on second growth of alfalfa, 1977 100

19 Influence of sewage effluent on snap bean growth, 1976 104

20 Influence of sewage effluent on snap bean growth, 1977 107

21 Influence of sewage effluents on carrot growth, 1976 113

22 Influence of sewage effluent on carrot growth, 1977 115

23 Influence of sewage effluent on the growth of corn, 1976 . . . 117

24 Influence of sewage effluent on the growth of corn, 1977 . . . 120

25 Influence of sewage effluent on the growth of lettuce, 1976 123

26 Influence of sewage effluent on the growth of lettuce, 1977 130

27 Influence of sewage effluent on the growth of onions, 1976 132

28 Influence of sewage effluent on the mean weekly growth (height - cm) of peas, 1976 135

29 Influence of sewage effluent on the mean weekly growth (height - cm) of peas, 1977 138

30 Influence of sewage effluent on the growth of potatoes . . . 142

31 Influence of sewage effluent on the mean weekly growth (cm) of radish plants, 1976 144

32 Influence of sewage effluent on the mean weekly growth (cm) of radish plants, 1977 146

33 Influence of sewage effluent on the mean weekly growth (height - cm) of tomato, 1976 151

FIGURES (CONTINUED)

Number Page

34 Influence of sewage effluent on the growth (cm) of wheat, 1976 152

35 Influence of sewage effluent on the growth (cm) of wheat, 1977 154

TABLES

Number		Page
1	Summary of data on cities with a history of irrigation with sewage effluent	10
2	Description of surface water sample stations	18
3	Water quality parameters monitored during the 1976 growing season (May to November, 1976)	19
4	Water quality parameters monitored and sample frequency during 1977 growing season (May to October, 1977)	20
5	Study of digestion of soil with nitric and perchloric acids (4:1 nitric-perchloric) for heavy metal content as affected by soil:acid ratio and digestion time	26
6	Comparisons of acid digestion procedures using either (1) nitric acid alone or (2) a mixture of 4 parts nitric and 1 part perchloric acid	27
7	Plants and seed type used in garden plots, 1976	28
8	Plants and seed type used in garden plots, 1977	28
9	Normal concentration ranges for the commonly found elements in soils and plants	33
10	Procedures for preparing 1,000 ppm standard solutions	34
11	Instrument settings for atomic absorption analysis using hollow cathodes	35
12	Summary of physical soil properties	38
13	Summary of water quality data collected during 1976 and 1977 growing seasons	39
14	Yearly average effluent quality of the Tooele, Utah, wastewater treatment plant	44

TABLES (CONTINUED)

Number | | Page
15 Comparison of average organic and inorganic concentrations of various parameters in water applied to the control and treated sites 47

16 Comparison of average metals concentrations in water applied to the control and treated sites with recommended limits for irrigation water 50

17 Residual organic concentrations measured at the treatment plant, treated site, and control site 51

18 Weight percentage of soil material (June 1976) larger than and smaller than 2 mm diameter 56

19 Weight percentage of soil material (September 1976) larger than and smaller than 2 mm diameter 57

20 Weight percentages of soil material (June 30, 1977) larger than and smaller than 2 mm diameter 58

21 Hydrometer textural analyses of the soil samples material smaller than two millimeter diameter collected from the Tooele soil sites June 30, 1977 59

22 Moisture percentages at field capacity (1/3 bar) and wilty point (15 bars) for soil samples taken June 1976 61

23 Field moisture contents of soil samples taken June 6, 1976 62

24 Field moisture content of soil samples taken from the deep core drilling hole (Figure 5, location DH-4) at the treated site during the week of June 14, 1976 63

25 Average ammonium-nitrogen and nitrate-nitrogen contents in soils sampled June 1976 64

26 Average ammonium-nitrogen and nitrate-nitrogen contents in soils sampled September 1976 65

27 Total nitrogen (Kjeldahl) contents in soils sampled September 1976 69

28 Total nitrogen (Kjeldahl) contents in soils sampled June 1977 70

TABLES (CONTINUED)

Number Page

29 Average total nitrogen (Kjeldahl) in the three top sampling depths (0-2, 2-4, and 9-11 cm) and the three deepest sampling depths (95-105, 195-205, and 295-305 cm) for the control site and the treated site in soils sampled in September 1976 and in June 1977 71

30 Concentration averages of phosphorus in the sodium bicarbonate extract of Tooele soil sampled June 6, 1976 73

31 Comparison of the phosphorus extracted by the procedure recommended for acidic soils (dilute $HCl-NH_4F$) and that recommended for calcareous and alkaline soils (0.5 normal $NaHCO_3$) 75

32 Combined nitrate plus ammonium nitrogen in soil moisture extracts using suction cups 77

33 Soluble salt contents (conductivity) of soil moisture extracts using suction cups 78

34 Average perchloric-nitric acid extractable trace metals in Tooele soils sampled May 1976 and September 1976 . . . 80

35 Average perchloric-nitric acid extractable trace metals in Tooele soils sampled June 1976, September 1976, and June 1977 81

36 Comparisons of profile totals from 0 to 55 cm (22 inches) of replication averages for trace metals in the control and treated sites 83

37 Statistical summary for analysis of variance for the trace metal content and less-than-2 mm portions for all soil depths to 300 cm (118 inches) of soils in the control and treated sites 84

38 Statistical summary for split plot analysis of variance for the trace metal content and less-than-2 mm portions for the top four depths of soils (0-32 cm) in the Tooele sewage-effluent disposal study 85

39 Trace metal concentrations in various fractions of the deep well profile 87

40 The copper and zinc extracted from Tooele soil samples (collected June 1977) as influenced by soil depth and by treatment with sewage effluent and compared to total nitric perchloric acid extractable amounts in the soils . . 88

TABLES (CONTINUED)

Number		Page
41	Summary of water quality of applied water to the control and treated garden plots	92
42	Influence of sewage effluent on mean weekly growth (height - cm) of first growth (first cutting) of alfalfa, 1976	94
43	Influence of sewage effluent on mean weekly growth (height - cm) of first growth (first cutting) of alfalfa, 1977	95
44	Influence of sewage effluent on first harvest alfalfa fresh and dry weights, percent moisture, and leaf/stem ratios, 1976	96
45	Influence of sewage effluent on first harvest alfalfa fresh and dry weights, percent moisture, and leaf/stem (L/S) ratios, 1977	96
46	Combined analysis of first harvests of alfalfa fresh weights for 1976 and 1977	97
47	Combined analysis of first harvests of alfalfa dry weights for 1976 and 1977	97
48	Combined analysis of first harvests of alfalfa leaf/stem (L/S) ratios for 1976 and 1977	98
49	Influence of sewage effluent on mean weekly growth (height - cm) of second growth (second cutting) of alfalfa, 1976	99
50	Influence of sewage effluent on mean weekly growth (height - cm) of second growth (second harvest) of alfalfa, 1977	100
51	Influence of sewage effluent on second harvest alfalfa fresh and dry weights, percent moisture, and leaf/stem ratios, 1976	101
52	Influence of sewage effluent on second harvest alfalfa fresh and dry weights, percent moisture, and leaf/stem ratios, 1977	101
53	Combined analysis of second harvest of alfalfa fresh weights for 1976 and 1977	102

TABLES (CONTINUED)

Number **Page**

54 Combined analysis of second harvests of alfalfa dry weights for 1976 and 1977 102

55 Combined analysis of second harvests of alfalfa leaf/stem (L/S) ratios for 1976 and 1977 103

56 Influence of sewage effluent on mean weekly growth (height - cm) of snap beans, 1976 104

57 Influence of sewage effluent on fresh and dry weights of plants, pods, and seeds of snap beans (harvested 1 meter or row), 1976 105

58 Influence of sewage effluent on yield components--number of pods per plant, seeds per pod, and average seed wt (gms)--and seed per meter of beans, 1976 106

59 Influence of sewage effluent on mean weekly growth (height - cm) of snap beans, 1977 107

60 Influence of sewage effluent on fresh and dry weights of bean plants, pods, and seeds--harvested 1 meter of row, 1977 108

61 Influence of sewage effluent on yield components--number of pods per plant, seeds per pod, seeds per meter, and average seed wt (gms) of beans, 1977 108

62 Combined analysis of fresh weights of bean plants for 1976 and 1977 109

63 Combined analysis of dry weights of bean plants for 1976 and 1977 109

64 Combined analysis of bean pod fresh weights for 1976 and 1977 109

65 Combined analysis of bean pod dry weights for 1976 and 1977 110

66 Combined analysis of bean seed fresh weight for 1976 and 1977 110

67 Combined analysis of bean seed dry weight for 1976 and 1977 110

68 Combined analysis of bean seeds per pod for 1976 and 1977 . . 111

TABLES (CONTINUED)

Number Page

69 Influence of sewage effluent on mean weekly growth (height - cm) of carrots, 1976 112

70 Influence of sewage effluent on fresh and dry weights percent moisture of shoots and roots and number of plants per meter of carrots, 1976 114

71 Influence of sewage effluent on mean weekly growth (height - cm) of carrots, 1977 115

72 Influence of sewage effluent on fresh and dry weights, percent moisture of shoots and roots, and number of plants per meter of carrots, 1977 116

73 Carrot root/shoot (R/S) ratios for 1976 and 1977 116

74 Combined analysis of carrot tops fresh weights for 1976 and 1977 118

75 Combined analysis of carrot root fresh weights for 1976 and 1977 118

76 Combined analysis of carrot tops dry weights for 1976 and 1977 118

77 Combined analysis of carrot root dry weights for 1976 and 1977 119

78 Combined analysis of dry weights of carrot root/shoot (R/S) ratios for 1976 and 1977 119

79 Influence of sewage effluent on the mean weekly growth (cm) of corn, 1976 119

80 Influence of sewage effluent on fresh and dry weights of corn plants and ears and percent moisture, 1976 . . . 121

81 Influence of sewage effluent on components of yield in corn, number of plants/meter, ears/meter, rows of kernels/ear, and kernels/row, 1976 121

82 Influence of sewage effluent on the mean weekly growth (height - cm) of corn, 1977 122

83 Influence of sewage effluent on fresh and dry weights of corn plants and ears and percent of moisture, 1977 122

TABLES (CONTINUED)

Number Page

84 Influence of sewage effluent on components of yield in corn, number of ears per meter, rows of kernels per ear, kernels per row, and weight of 100 seeds, 1977 . . 124

85 Combined analysis of corn plant fresh weights for 1976 and 1977 125

86 Combined analysis of corn plant dry weights for 1976 and 1977 125

87 Combined analysis of corn ear fresh weights for 1976 and 1977 125

88 Combined analysis of corn ear dry weights for 1976 and 1977 . . 126

89 Combined analysis of corn ears per meter for 1976 and 1977 126

90 Combined analysis of corn kernel rows per ear for 1976 and 1977 126

91 Influence of sewage effluent on mean weekly growth (height - cm) of lettuce, 1976 127

92 Influence of sewage effluent on fresh and dry weights of lettuce plants (10 plants per replication per treatment), 1976 128

93 Influence of sewage effluent on mean weekly growth (height - cm) of lettuce, 1977 129

94 Influence of sewage effluent on fresh and dry weights of lettuce plants (10 plants per replication per treatment), 1977 131

95 Combined analysis of lettuce fresh weights for 1976 and 1977 131

96 Combined analysis of lettuce dry weights for 1976 and 1977 131

97 Influence of sewage effluent on mean weekly growth (height - cm) of onions, 1976 132

98 Influence of sewage effluent on fresh and dry weights, number of plants per meter, and percent moisture in onions 133

TABLES (CONTINUED)

Number Page

99 Influence of sewage effluent on mean weekly growth (height - cm) of peas, 1976 134

100 Influence of sewage effluent on fresh and dry weights of plant, pods, and seeds of peas (harvested 1 m - row), 1976 136

101 Influence of sewage effluent on yield components of peas, number of plants per meter, number of pods per plant, number of seeds per pod, average seed weight, and seeds per meter, 1976 137

102 Influence of sewage effluent on mean weekly growth (height - cm) of peas, 1977 138

103 Influence of sewage effluent on fresh and dry weights of plants and percent moisture of peas, 1977 139

104 Influence of sewage effluent on yield components--number of plants per meter, number of pods per plant, number of seeds per pod, and seeds per meter, 1977 139

105 Combined analysis of pea plant fresh weights for 1976 and 1977 140

106 Combined analysis of pea plant dry weights for 1976 and 1977 140

107 Combined analysis of number of pea plants per meter for 1976 and 1977 140

108 Combined analysis of number of pea pods per plant for 1976 and 1977 141

109 Combined analysis of number of pea seeds per pod for 1976 and 1977 141

110 Influence of sewage effluent on mean weekly growth (height - cm) of potatoes, 1976 142

111 Influence of sewage effluent on the number of U.S. No. 1, 2, and 3 grade of potatoes (total for five plants) . . . 143

112 Influence of sewage effluent on the mean weekly growth (cm) of radish, 1976 144

TABLES (CONTINUED)

Number Page

113 Influence of sewage effluent on the fresh and dry weights (gms) and the root/shoot (R/S) ratio of radish, 1976 . . 145

114 Influence of sewage effluent on the mean weekly growth (cm) of radish, 1977 146

115 Influence of sewage effluent on the fresh and dry weights and the root/shoot (R/S) ratio of radish, 1977 147

116 Combined analysis of radish tops fresh weights for 1976 and 1977 148

117 Combined analysis of radish tops dry weights for 1976 and 1977 148

118 Combined analysis of radish roots fresh weights for 1976 and 1977 148

119 Combined analysis of radish roots dry weights for 1976 and 1977 149

120 Combined analysis of fresh weights of radish root/shoot (R/S) ratios for 1976 and 1977 149

121 Combined analysis of dry weights of radish root/shoot (R/S) ratios for 1976 and 1977 149

122 Influence of sewage effluent on the mean weekly growth (cm) of tomato, 1976 150

123 Influence of sewage effluent on the mean weekly growth (height - cm) of wheat, 1976 150

124 Influence of sewage effluent on fresh and dry weights (gms) of wheat plants and seed and percent moisture (harvested 1 meter of row), 1976 153

125 Influence of sewage effluent on yield components--average number of plants meter, number of seeds per head, and average seed weight of wheat, 1976 153

126 Influence of sewage effluent on the mean weekly growth (height - cm) of wheat, 1977 154

127 Influence of sewage effluent on fresh and dry weights (gms) of wheat plants and seed and percent moisture (harvested 1 meter of row), 1977 . . . .

TABLES (CONTINUED)

Number Page

128 Influence of sewage effluent on yield components--number of plants per meter, number of seeds per head, average seed weight, and seeds per meter, 1977 155

129 Combined analysis of wheat plants fresh weights for 1976 and 1977 156

130 Combined analysis of wheat plants dry weights for 1976 and 1977 156

131 Combined analysis of fresh weights of 100 wheat seeds for 1976 and 1977 156

132 Combined analysis of dry weights of 100 wheat seeds for 1976 and 1977 157

133 Average mean value in percent and ppm (parts per million) for calcium (Ca), potassium (K), nitrogen (N), phosphorus (P), cadmium (Cd), copper (Cu), iron (Fe), sodium (Na), lead (Pb), and zinc (Zn), respectively for the various plants tested 158

LIST OF ABBREVIATIONS AND SYMBOLS

ac = acre
Al = aluminum
Ar = arsenic
B = boron
BOD_5 = five day biochemical oxygen demand
Ca = calcium
Cd = cadmium
Cl = chloride
COD = chemical oxygen demand
Cr = chromium
Cu = copper
DO = dissolved oxygen
EC = electrical conductivity
Fe = iron
ft = feet
gal = gallons
gpd = gallons per day
gpm = gallons per minute
HCB = hexachloro benzene
Hg = mercury
in. = inch
K = potassium
Kg/ha = kilogram per hectare
km = kilometer
ℓ = liter
lbs/acre = pounds per acre
m = meter
M-Ent. = M-Enterococcus
m^3/day = cubic meters per day
MF = membrane filter
Mg = magnesium
mg/l = milligram per liter
Mn = manganese
MPN = most probable number
N = nitrogen
Na = sodium
NH_3-N = ammonia nitrogen
Ni = nickel
NO_2-N = nitrite nitrogen
NO_3-N = nitrate nitrogen
Pb = lead
PCB = poly chlorinated biphenols
ppb = parts per billion
ppm = parts per million
SAR = sodium adsorption ratio
Temp = temperature
TKN = total Kjeldahl nitrogen
Tot = total
Zn = zinc
μg/l = micrograms per liter
μmhos/cm = micromhos per centimeter
< = less than
> = greater than

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SECTION 1

INTRODUCTION

NATURE OF THE PROBLEM

Application of municipal wastewater to the land or using the soil mantle as a "wastewater treatment system" has been designated a viable alternative for wastewater treatment by the Water Pollution Act Amendment of 1972 (PL 92-500). Land application systems may be classified as (i) high rate or rapid infiltration (ii) overland flow or (iii) slow rate or crop irrigation. Many municipalities and industries have expressed interest in the implementation of land treatment systems.

Land application of wastewater dates back to ancient Greece and has been practiced in Europe and the United States prior to the turn of the century. However, very little information exists concerning the long term effects of applying wastewater to the land. This information is urgently needed to develop sound design criteria for land application systems. The purpose of this study is to determine the long term effects of applying wastewater to the land.

OBJECTIVES

General Objective

The general objective of the study was to determine the long term effects of employing secondary treated municipal wastewater as irrigation water. The study compared the quality of soils, crops, groundwater, and raw water applied to a site receiving normal irrigation (control site) to a site which had utilized secondary treated municipal effluent for irrigation water during a 20 year period (treated site). Similar management practices were applied at both sites.

Specific Objectives

To accomplish the above general objective the following specific objectives were to be achieved at the control site and at the treated site.

1. Select a suitable site for conducting the study.

2. Determine and analyze the historical management of each site.

3. Determine the present soil, plant, and water (surface and groundwater) characteristics of each site.

4. Determine the distribution (water, soil, plant) of selected measurable parameters (bacteriological, organic, nutrients, heavy metals, and salts) within each site, and thus, determine the fate or "pathway" of each parameter.

5. Relate the present soil characteristics, distribution of selected parameters, plant characteristics, and surface and groundwater quality to historical site management.

6. Determine the effect of applying wastewater to the land on the engineering soil properties during the time of application of the wastewater and after the application of the wastewater has ceased.

SCOPE

The results of the project are contained in two separate volumes. Volume I contains the results and discussion of field data collected during 1976 and 1977 which relates to the field evaluation (Specific Objectives 1 through 5 above). Volume II reports the results of field investigations and laboratory studies to determine the effects on engineering soil properties (Specific Objective 6) of applying wastewater to the land for long periods of time.

SECTION 2

CONCLUSIONS

Based on the results of a two year study at Tooele, Utah, to determine the long term effects of land applications of secondary treated municipal wastewater, the following conclusions can be made.

1. The soil profile of the study site consisted of silt and silty clay overlaying gravelly silt. Deep boring indicated sandy gravel and silty gravel to a depth of 33 meters (m) [107 feet (ft)].

2. Below the top 60 to 90 centimeters (cm) [24 to 35 inches (in)] the soils were quite cobbly and gravelly. Many deep borings contained over 50 percent of the material coarser than 2 millimeters (mm) (0.08 in).

3. Historically (1957 to 1976), the Tooele, Utah, Wastewater Treatment Plant produced an effluent with a yearly average biochemical oxygen demand (BOD_5) concentration between 9 mg/l and 49.8 mg/l. The yearly average suspended solids concentrations from 1957 to 1976 ranged from 21 mg/l to 26 mg/l.

4. The Tooele, Utah, Wastewater Treatment Plant mean effluent BOD_5 concentrations in 1976 and 1977 were 29 mg/l and 16 mg/l respectively. The mean effluent suspended solids concentrations during 1976 and 1977 were 49.8 mg/l and 31.0 mg/l respectively.

5. The treated site had been flood irrigated with the secondary treated wastewater from 1957 to 1976. In 1976 and 1977, a portion of the treated site was sprinkler irrigated and a portion was flood irrigated.

6. During 1976 and 1977, 28.08 cm/irrigation (11.06 in/irrigation) and 16.38 cm/irrigation (6.45 in/irrigation) respectively was applied by flood irrigation to the treated site. Therefore, it was estimated that the yearly average annual application rate at the treated site from 1957 to 1976 was 60.84 cm/year (23.95 in/year). This is a relatively low application rate for slow rate land application systems.

7. The control site had been sprinkler irrigated since 1966. In 1976 and 1977, the application rate of normal irrigation water applied to the control site was 1.92 cm/week (0.76 in/week) and 2.41 cm/week (0.95 in/week) respectively. Based on these measurements, it was estimated that the yearly average application rate from 1966 to 1975 at the control site was 39.68 cm/year (15.62 in/year).

8. The estimated yearly average application rate of the treated site was 1.5 times greated than the estimated yearly average annual application rate of the control site. This difference is a result of the different irrigation methods employed at the two sites.

9. The average biochemical oxygen demand concentration (BOD_5) of treated effluent applied to the treated site was 14.1 mg/l in 1976 and 16.0 mg/l in 1977. The average biochemical oxygen demand concentration (BOD_5) of irrigation water applied to the control site was 1.6 mg/l in 1976 and 2.5 mg/l in 1977. Although treated effluent contained significant (95 percent level) more biodegradable material than the irrigation water, the quality of the applied effluent was relatively high compared to many land application systems.

10. The average suspended solids concentration of treated effluent applied to the treated site were 30.9 mg/l in 1976 and 59.2 mg/l in 1977. The average suspended solids concentrations of irrigation water applied to the control site were 2.2 mg/l in 1976 and 5.8 mg/l in 1977. The suspended solids concentration of the treated effluent was significantly (95 percent level) greater than the irrigation water and is typical of secondary treated municipal effluent.

11. The concentration of the various nutrient species (NH_3-N, NO_2-N, NO_3-N, TKN, total phosphorus, total soluable phosphorus and ortho phosphorus) in the treated effluent were greater than those of the irrigation water, however, these concentrations are slightly less than those for wastewater normally employed in land application.

12. The average total dissolved solids concentration of the treated effluent applied to the treated site were 656.7 mg/l in 1976 and 608.4 mg/l in 1977 and was apparently three times greater than the total dissolved solids concentration of the irrigation water applied to the control site. These values are typical of domestic wastewater and acceptable for water to be used for irrigation.

13. The metals concentrations of both the treated effluent and the irrigation water were less than limiting concentration recommended for irrigation water.

14. Groundwater was not encountered within 33 meters (107 feet) of the ground surface. Thus, direct determination of groundwater quality was not possible. At no time during the growing season (application season) did precipitation and application of wastewater exceed the calculated evapotranspiration. Suction tubes and lysimeters were installed to determine the percolate water quality, however, due to drought conditions the results were inconclusive.

15. Soils analysis indicated that nitrogen is accumulated in the top 2 to 3 meters (6.5 to 10 feet) of the treated site, but is not moving in appreciable quantities to greater depths.

16. The treated site had large concentrations of available phosphorus (5 to 6 times greater than the control site) to depths of 3 meters (10 feet). The accumulation of available phosphorus in the top 50 cm (20 inches) of soil is probably due to application of the treated municipal effluent.

17. Concentrations of heavy metals (lead, copper, nickel, cadmium, zinc, and chromium) were greater at depths above 30 cm (12 inches) than below 30 cm (12 inches) in both the treated and control sites.

18. The concentrations of heavy metals (lead, copper, nickel, cadmium, zinc, and chromium) in the soils at the control and treated sites were greater than normally found in natural soil. This is probably due to air pollution fallout from two smelters located within 32 kilometers (km) (20 miles) of the study site.

19. In the top 30 cm (12 inches) of soil none of the heavy metals concentrations, except chromium, in the treated site was significantly different (95 percent level) from the control site. The concentration of chromium was significantly higher (95 percent level) in the top 30 cm (12 inches) of the control site than in the treated site.

20. There is no clear evidence of increased cadmium, lead, zinc, copper, chromium or nickel contents in the treated site soils after 20 years of treated municipal wastewater application.

21. The soil analysis performed cannot provide any negative aspect to the use of secondary treated municipal wastewater for land application after 20 years of use.

22. In general, plants grown in the control garden plot were significantly higher in heavy metals (copper, iron, and zinc) than plants grown on the treated garden plots.

23. In general, the heavy metals content of plants in the study were lower than amounts reported to be harmful.

24. Plants grown on the treated garden plot had higher levels of sodium than plants grown on the control garden plot. Plants grown on the treated garden plot generally exhibited greater growth than plants grown on the control garden plot.

25. The results of this study indicate no harmful effects on soils, crops, or water quality have occurred from land application of secondary treated municipal effluent at Tooele, Utah since 1957.

SECTION 3

RECOMMENDATIONS

1. Further studies to determine the level of necessary pretreatment of municipal wastewater prior to land application is needed to establish satisfactory land application design criteria.

2. Several studies to determine the long term effects of land application of wastewater have been completed. A comprehensive comparison of these various studies is needed to clearly define the long term effects of land application of wastewater.

3. The transport, pathway, and fate of pathogens in land application systems should be clearly defined.

4. The transport, pathway, and fate of refactory organic compounds in land applications systems should be clearly defined.

SECTION 4

METHODS

GENERAL

The general objective of this study was to determine the long-term effects of applying domestic wastewater to the land as irrigation water. This objective was achieved by selecting a site which had employed secondary treated municipal effluent as irrigation water for twenty years and comparing the water, soil, and plant characteristics of this site (treated site) with a similar site (control site) which had employed "normal" irrigation water for a similar period. The surface and groundwater of each site was assessed by monitoring the water quantity and quality. Soil characteristics of each site were compared by samples collected at both sites. The effects on plant characteristics were determined by sampling the in-situ vegetation at each site and by establishing small garden plots at each site. Various crops were grown in each plot and the results compared to determine the effects of irrigation with wastewater on plant growth, character, and production.

The study was divided into four phases. Phase I: Site Selection was designed to objectively evaluate the various sites available for the study and to select the control and treated site best suited to the project objectives. Phase II: Field Data Collection and Analysis was designed to collect all data necessary to evaluate the long-term effects of applying municipal wastewater to the land. This phase was conducted during two separate growing seasons. The first growing season extended from May 1976 to October 1976, while the second season covered May 1977 to October 1977. This phase was divided into three separate tasks. Task 1: Water Quality and Quantity was designed to determine the amount and character of the water applied to the control and treated sites. Task 2: Soil Characteristics was designed to determine the physical and chemical composition of the control and treated sites. Task 3: Plant Characteristics was designed to determine the character, growth rate, and production of various plants grown on the control and treated sites. Phase III: Engineering Soil Properties was a laboratory study to determine the long-term effects of applying municipal wastewater on the engineering soil properties of various soils. This phase of the study is reported in Volume II of this report. Phase IV: Data Analysis and Comparison was designed to compare the data obtained from the control and treated sites and to determine the long-term effects of applying municipal wastewater to the land.

SITE SELECTION

General

Specific minimum site criteria were established by the U.S. Environmental Protection Agency (EPA) project staff. The Utah Water Research Laboratory (UWRL) research team developed additional rating criteria that were combined with the EPA requirements, for selection of the most desirable site.

EPA Criteria

The minimum EPA site criteria were summarized in a letter from Mr. Richard E. Thomas, U.S. Environmental Protection Agency, Robert S. Kerr Environmental Research Laboratory, (Thomas, 1976), dated January 23, 1976.

> Desirable site conditions covered included pretreatment, size, age, and type of crop. Pretreatment should be primary or conventional secondary, and we will select more sites with secondary pretreatment. Daily flows of about 0.1 mgd will be the lower limit on size, and there is no upper limit. Sites older than 19 years are not only acceptable but are desirable. We want to have a good spread in system age. The type of crop can vary over a wide range, but the system should be representative of common usage. Once again, we will be looking for a range of practices which could include such uses as golf courses, high-value cash crops, and pasture land. Of course, high-rate infiltration systems do not have cropping as a general rule.

Utah Water Research Laboratory Selection Criteria

- Daily flows greater than 0.1 mgd
- Quality of effluent

  Suspended Solids (SS) > 30 mg/1
  Biochemical Oxygen Demand (BOD_5) > 30 mg/1
- Land application for more than 10 years
- Paired site within 1 mile
- Travel distance less than 240 km (150 miles) from Utah State University, Logan, Utah
- Soil texture - avoid high percolation soils such as sand
- Depth to groundwater table less than 6 m (20 feet)
- Depth to hardpan or bedrock > 6 m (20 feet)
- Topography - slope less than 5 percent

- Percolation site (minimum runoff)
- Land owner cooperation essential
- Availability of site history (disposal and paired site)
- Establish geologic and hydrologic characteristics of the groundwater system
- Accessibility of the sites

It was anticipated that no site would be able to meet all of the above criteria. However, the criteria did provide a method for selecting the most desirable site.

Sites Considered

The 1971 inventory of "Domestic Wastewater Facilities in Utah" identified fifteen municipalities which were presently or had a history of applying sewage treatment plant effluent to the land. Assistance was also provided by the State of Utah, Division of Health, Bureau of Water Quality. In addition to the fifteen Utah sites, preliminary data were obtained from Ely, Nevada, in case an acceptable site could not be found in Utah. Preliminary information concerning the quantity and quality of the treatment plant effluent, the characteristics of the irrigation operation and the history of the land disposal site was obtained by telephone from each city. This information is summarized in Table 1.

Based on analysis of the information in Table 1, five sites were selected for site visits by the project team. These sites included Logan, Spanish Fork, Springville, St. George, and Tooele. These initial site visits indicated that the Logan, St. George, and Tooele sites were the best sites because the treatment plant records were complete, the land use history of the disposal area and the base site could be readily established and, in general, they best satisfied the site criteria established by the project team.

After a complete evaluation of all the available information, including a site visit with the Project Officer to the St. George, Logan, and Tooele, Utah, sites, the Tooele site was selected for the study.

SITE DESCRIPTION

Treatment Plant

The community of Tooele, Utah, is located approximately 48 km (30 miles) west of Salt Lake City, Utah, and has a population of about 3,800 people. The community has a relatively large commercial district, but does not contain any major industries. The climate is semi-arid with an annual precipitation of 42 cm (16.5 inches). Mean monthly temperatures range from -2°C (28.8°F) in January to 24°C (75.4°F) during July. The community sits at an elevation of 8676 m (4820 ft) above mean sea level.

TABLE 1. SUMMARY OF DATA ON CITIES WITH A HISTORY OF IRRIGATION WITH SEWAGE EFFLUENT

Site	Type of Treat-ment	Flow[a] Rate MGD	BOD[a] (mg/1)	SS[a] (mg/1)	Time of Ap-plication (years)	Base Site Avail-able	GWT[b] (ft)	
Logan, Utah	L	12	3	10	>50	Yes	4-summer	Untreated sewage applied to some areas prior to 1967. Artesian aquifers underlying much of the area.
Blanding, Utah	L	0.22	> 30	Class D	16	Yes		Farmer takes overflow from lagoons to irrigate 10 acre hay field. About .25 cfs spring and summer.
Tooele, Utah	TF	1.4	27	25	>10	Yes	> 20	New construction to start spring of 1976. Complete records.
St. George, Utah	TF	1.3	16	12	>40	Yes	3	Untreated sewage applied prior to 1966. One field has only received treated effluent. Complete records.
Spanish Fork, Utah	TF	2.2	Class D	Class D	>10	Yes	3	Irrigate golf course.
East Carbon City, Ut.	L	0.21						No irrigation.
Sunnyside, Utah	Imhoff tank	0.6	15	13	>12			Intermittent application to golf course.
Springville, Utah	TF	2.75	21	24	>10	Yes	1	Commingled with spring water. City and private land (pasture) irrigated.
Ely, Nevada								
Huntington, Utah	L		100		>20	Yes	2-6	High alkaline clay soil. No crops. Swamp area.
Wendover, Utah	L	0.15						Total containment now.
Ephraim, Utah	L	0.25						Total containment.
Kanab, Utah		0.17						
Nephi, Utah	L	0.28						Total containment.
Pleasant Grove, Ut.	TF		Class D	Class D				Commingled with Pleasant Grove waste ditch.

[a] Spot sample of treatment plant records.

[b] Estimated by person being interviewed.

The Tooele Wastewater Treatment Plant began operation in 1957 with a design capacity of 8327 m^3/day (2.2 mgd). In 1957, the plant consisted of grit removal, primary sedimentation, conventional trickling filter, secondary sedimentation, chlorination, and anaerobic sludge digestion with sand drying beds. The average daily flow to the plant was less than 3028 m^3/day (0.8 mgd) in 1957, but gradually increased to over 3785 m^3/day (1.0 mgd) by 1961.

Enactment of stringent effluent discharge standards by the State of Utah required the treatment plant to be upgraded. In the spring of 1977 the treatment plant was converted to a two stage trickling filter plant. Also, the secondary clarifier capacity was more than doubled.

The treatment plant effluent has been under contract to a local land owner since the plant began operation in 1957. This contract allows the land owner to use the plant effluent for crop irrigation and stock watering. The management of the treatment plant effluent once it leaves the treatment plant site is controlled by the land owner. The City of Tooele does not control the land application of the treated effluent.

The land owner controls approximately 486 hectares (ha) (1200 acres) of crop and pasture land. Management of the wastewater has been directed toward crop production rather than wastewater disposal. Thus, the land owner attempts to irrigate as much land as possible with the treatment plant effluent. Frequently, since 1957, treatment plant effluent has been co-mingled with normal irrigation water to assist with crop production. However, the specific sites selected for this study have not received any co-mingled water.

The historical performance of the treatment plant and the effluent quality determined during this study is presented in the results section of this report.

Experimental System

The experimental system is shown in Figure 1. The treatment plant effluent flows approximately 0.40 km (0.25 mile) through an earthen ditch to the first holding reservoir which is approximately 0.2 ha (0.5 acre) in area and has an average depth of less than 1.8 m (6 feet). This reservoir provides minimum storage and was designed to settle solids which escaped the secondary clarifier. The reservoir is very shallow and suffers from hydraulic short circuiting.

Near the outlet of the first holding reservoir is a pump station intake used to provide sprinkler irrigation for several adjacent fields. This point also provides the intake for effluent applied to the spray irrigation portion of the treated site. Sprinkler irrigation of the treated site did not begin until 1976. Prior to 1976 the entire treated site was flood irrigated with treatment plant effluent from the second holding reservoir.

From the first holding reservoir the water flows approximately 1.6 km (1 mile) through an earthen ditch to the second reservoir which is approximately 0.05 ha (0.125 acre) and has an average depth greater than 3 m (10 feet). This holding reservoir is used primarily for storage and control of effluent application to various irrigated fields.

Treated Site

Historically, the treated site has been flood irrigated with treatment plant effluent stored in the second reservoir. However, as mentioned earlier, in 1976, a sprinkler irrigation line was installed near the outlet of the first holding reservoir and after that time a portion of the treated site was sprinkler irrigated with treatment plant effluent from the first reservoir.

The treated site is shown in Figure 2 and consists of 14 ha (34.5 acres) total. The treated site consists of the second holding reservoir, a 10.5 ha

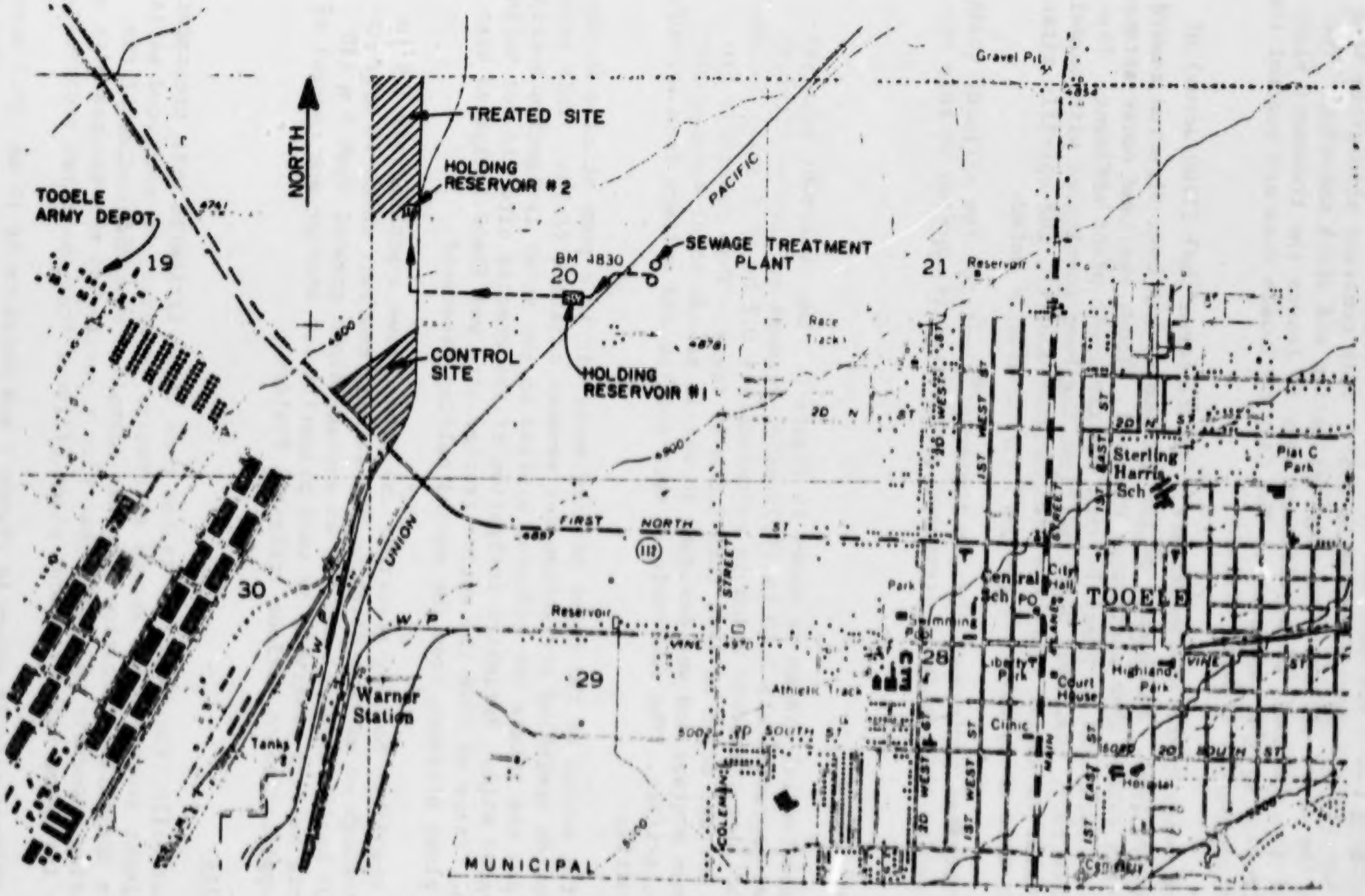

NORTH
TREATED SITE
HOLDING RESERVOIR #2
TOOELE ARMY DEPOT
19
20
21
BM 4830
SEWAGE TREATMENT PLANT
HOLDING RESERVOIR #1
CONTROL SITE
PACIFIC
UNION
Gravel Pit
Reservoir
Race Track
20 N ST
Sterling Harris Sch
Plat C Park
FIRST NORTH ST
111
30
W P
Warner Station
Tanks
Reservoir
29
VINE
STREET
Park
Central Sch
City Hall
PO
TOOELE
Swimming Pool
28
Liberty Park
Court House
Highland Park
Athletic Track
Clinic
Hospital
2D SOUTH ST
2D WEST ST
1ST WEST ST
MAIN STREET
1ST EAST ST
COLEMAN
MUNICIPAL
Cemetery

Figure 1. Location map.

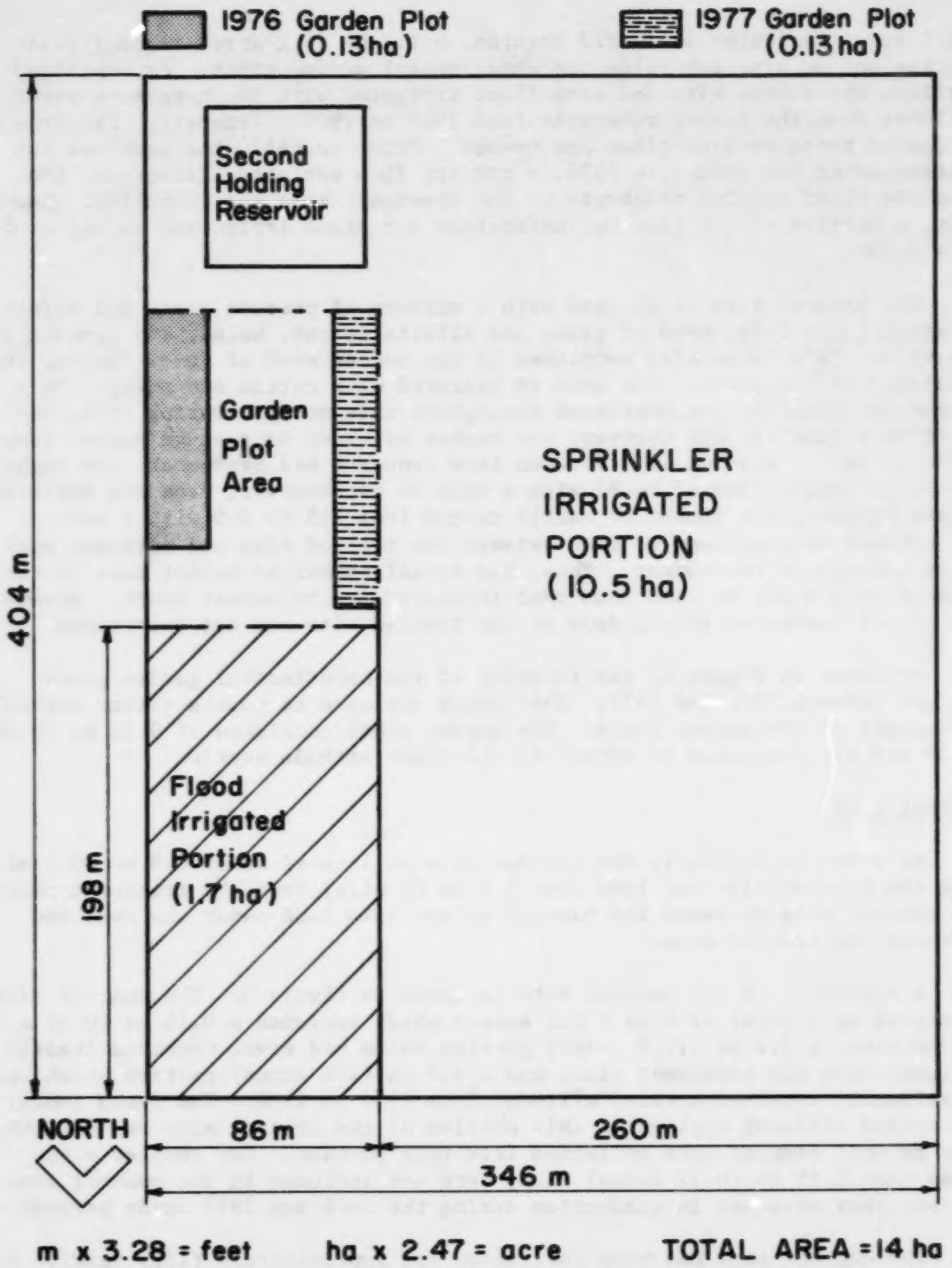

1976 Garden Plot (0.13 ha)
1977 Garden Plot (0.13 ha)
Second Holding Reservoir
Garden Plot Area
SPRINKLER IRRIGATED PORTION (10.5 ha)
Flood Irrigated Portion (1.7 ha)
404 m
198 m
NORTH
86 m
260 m
346 m
m x 3.28 = feet
ha x 2.47 = acre
TOTAL AREA = 14 ha

Figure 2. Schematic of treated site.

(25.2 acre) sprinkler irrigated portion, a 1.7 ha (4.2 acre) flood irrigation portion and an area set aside for experimental garden plots. As mentioned earlier, the entire site had been flood irrigated with the treatment plant effluent from the second reservoir from 1957 to 1976. Generally, the area was irrigated three or four times per season. Prior to 1957, the land was not cultivated or pastured. In 1976, a gravity flow sprinkler irrigation line from the first holding reservoir to the treatment site was installed. However, a portion of the site was maintained for flood irrigation to assist with this study.

The treated site is planted with a mixture of pasture grass and alfalfa. Generally, the first crop of grass and alfalfa is cut, baled, and removed from the site. This is usually completed by the second week of June. During the remainder of the season, the area is pastured with cattle and sheep. This management practice was continued throughout this study. During 1976, between late June and mid October, the number of sheep on pasture ranged from 45 to 58 with a mean of 49. Between late June and mid September, the number of cattle ranged from 47 to 87 with a mean of 64; however, from mid September to mid October, the number of cattle ranged from 115 to 149 with a mean of 125. The animals were allowed to move between the treated site and adjacent pastures throughout the summer. Thus, the actual number of animal days on the treated site would be less than that indicated by the animal count. However, the actual number of animal days on the treated site was not determined.

As shown in Figure 2, the location of the experimental garden plots shifted between 1976 and 1977. This shift was made to enable easier sprinkler irrigation of the garden plots. The garden plots consisted of 0.13 ha (0.32 acre) and are described in detail in the plant methods section.

Control Site

As shown in Figure 1, the control site is located about 0.8 km (0.5 mile) from the treated site and less than 1.6 km (1 mile) from the treatment plant. The control site is owned and managed by the same land owner who owns and operates the treated site.

A schematic of the control site is shown in Figure 3. The control site consisted of a total of 9 ha (22.2 acres) which included a 0.15 ha (0.37 acre) garden plot, a 7.2 ha (17.8 acres) portion which had never received treated effluent from the treatment plant and a 1.7 ha (4.2 acres) portion which had occasionally received treated effluent from 1957 to 1966. The exact amount of treated effluent applied to this portion of the control site was unknown, thus no soil samples were collected from this portion. Two smaller areas [less than 0.15 ha (0.37 acres) each] were not included in the control site because they were not in production during the 1976 and 1977 study periods.

The control site has been cultivated for approximately fifty years. However, it has only been irrigated since 1966. Prior to 1966, this area was under dry farm cultivation. Construction of a storage reservoir in the mountains east of Tooele was completed in 1966 by the Settlement Canyon Irrigation Company. Water from this reservoir was used to irrigate the control site from 1966 to the present. The site has received three to four irrigations per season since 1966.

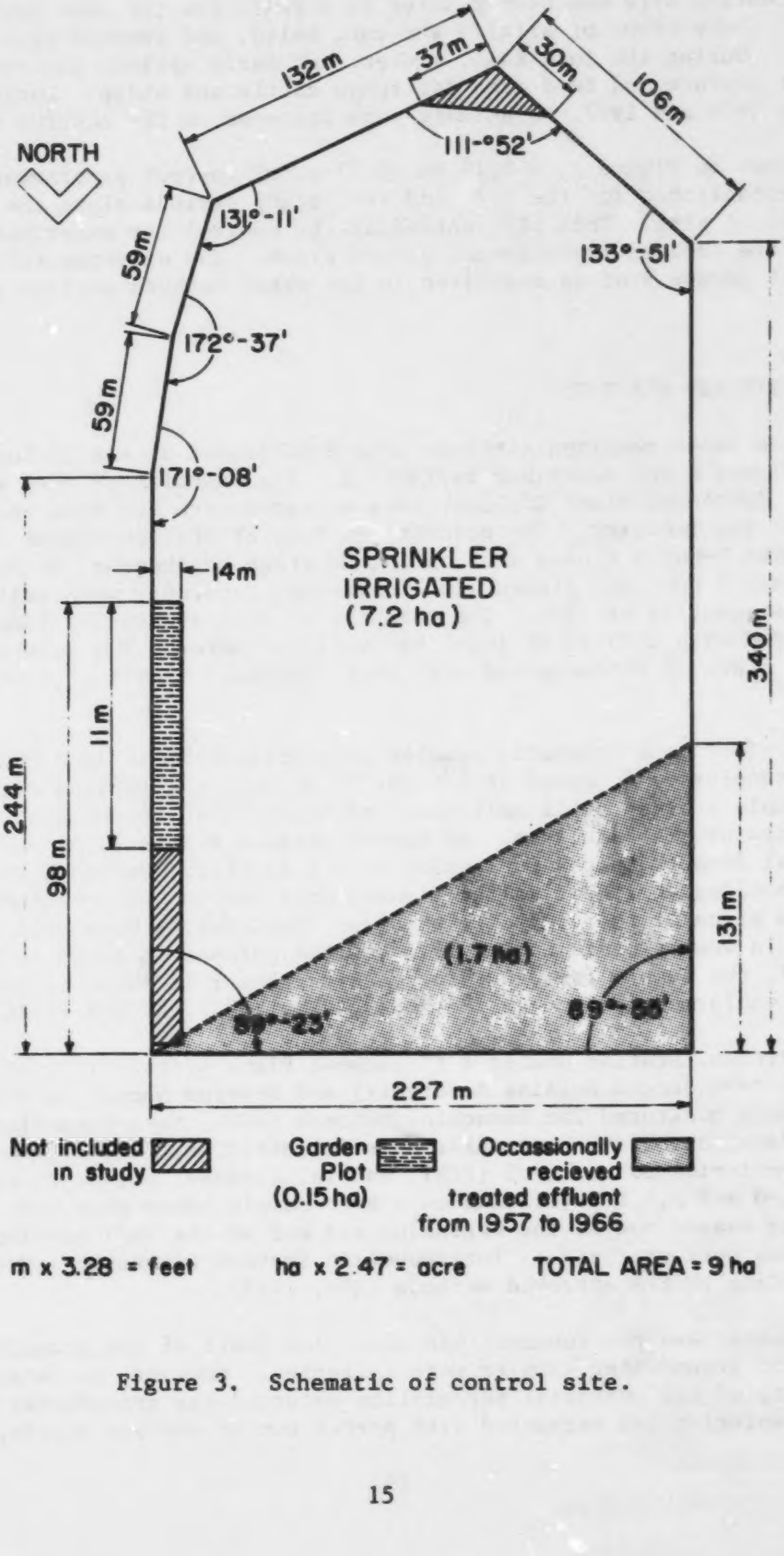

NORTH
132 m
37 m
30m
106m
111-°52'
131°-11'
133°-51'
59m
172°-37'
59 m
171°-08'
14m
SPRINKLER
IRRIGATED
(7.2 ha)
340 m
11 m
244 m
98 m
131 m
(1.7 ha)
89°-23'
89°-56'
227 m
Not included in study
Garden Plot (0.15 ha)
Occassionally recieved treated effluent from 1957 to 1966
m x 3.28 = feet
ha x 2.47 = acre
TOTAL AREA = 9 ha

Figure 3. Schematic of control site.

The control site has been planted in alfalfa for the past few years. Generally, these crops of alfalfa are cut, baled, and removed from the site each year. During the late fall, winter, and early spring, the area is used for winter pasture and feed area for range cattle and sheep. During May to October of 1976 and 1977, no animals were pastured on the control site.

As shown in Figure 3, a 0.15 ha (0.37 acre) control experimental garden plot was established for the 1976 and 1977 study periods along the east side of the control site. This plot served as the control for experiments conducted on the treated experimental garden plots. The experimental design of the control garden plot is described in the plant methods section of this report.

WATER QUALITY AND QUANTITY

Surface water sampling stations were established at the 11 locations shown in Figure 4 and described in Table 2. The quantity of flow at Station Number 1: Treatment Plant Effluent, was measured with the flow recorder existing at the facility. The quantity of flow at Station Number 2 and 3 was measured with V-notch flumes and continuous stage recorders. At Station Number 4, 5, and 7 bob-tail flumes with continuous recorders were employed to measure the quantity of flow. The quantity of flow at Station Number 8 and 9 was monitored with a 10 cm (4 inch) Rockwell flowmeter. The quantity of flow at Station 6 and 10 was measured with small Parshall flumes with stage recorders.

Twenty-four hour composite samples were obtained with ISCO Model 1580 composite samplers and stored at 2°C (34°F) in propane operated refrigerators at each sample station until collected and transported to the Utah Water Research Laboratory for analysis. At Sample Station Number 1, 5, and 7, flow proportional 24-hour composite samples were collected. On those occasions when the sampling equipment malfunctioned, grab samples were collected and analyzed in place of the composite samples. The samples were collected and analyzed on a weekly basis during 1976 for the parameters shown in Table 3. During 1977, the sample frequency for each parameter is shown in Table 4. All procedures conformed to Standard Methods (APHA, 1975) and EPA (1974).

In addition, Station Number 1 (Treatment Plant Effluent), Station Number 4 (Effluent from Second Holding Reservoir) and Station Number 11 (Control Site Influent) were monitored for hexachlorobenzene (HCB), beta-hexachlorobenzene (BBHC), aldane, oxychlor, heptachlor epoxide, dieldrin, DDT, organo-phosphorus, sevin, polychlorinated biphenol (PCB), endrin, lindane, methoxychlor, toxophene, 2,4,-D and 2,4,5-T (silvex) on a grab sample taken near the end of the 1976 growing season and at the beginning and end of the 1977 growing season. These samples were analyzed by Intermountain Systems Laboratory, Midvale, Utah, according to EPA approved methods (EPA, 1977).

Groundwater was not found within 30 m (100 feet) of the ground surface. Therefore, no groundwater samples were collected. However, to determine the water quality of the potential percolation water to the groundwater table, soil-water solution was extracted with porous cup at various depths. In

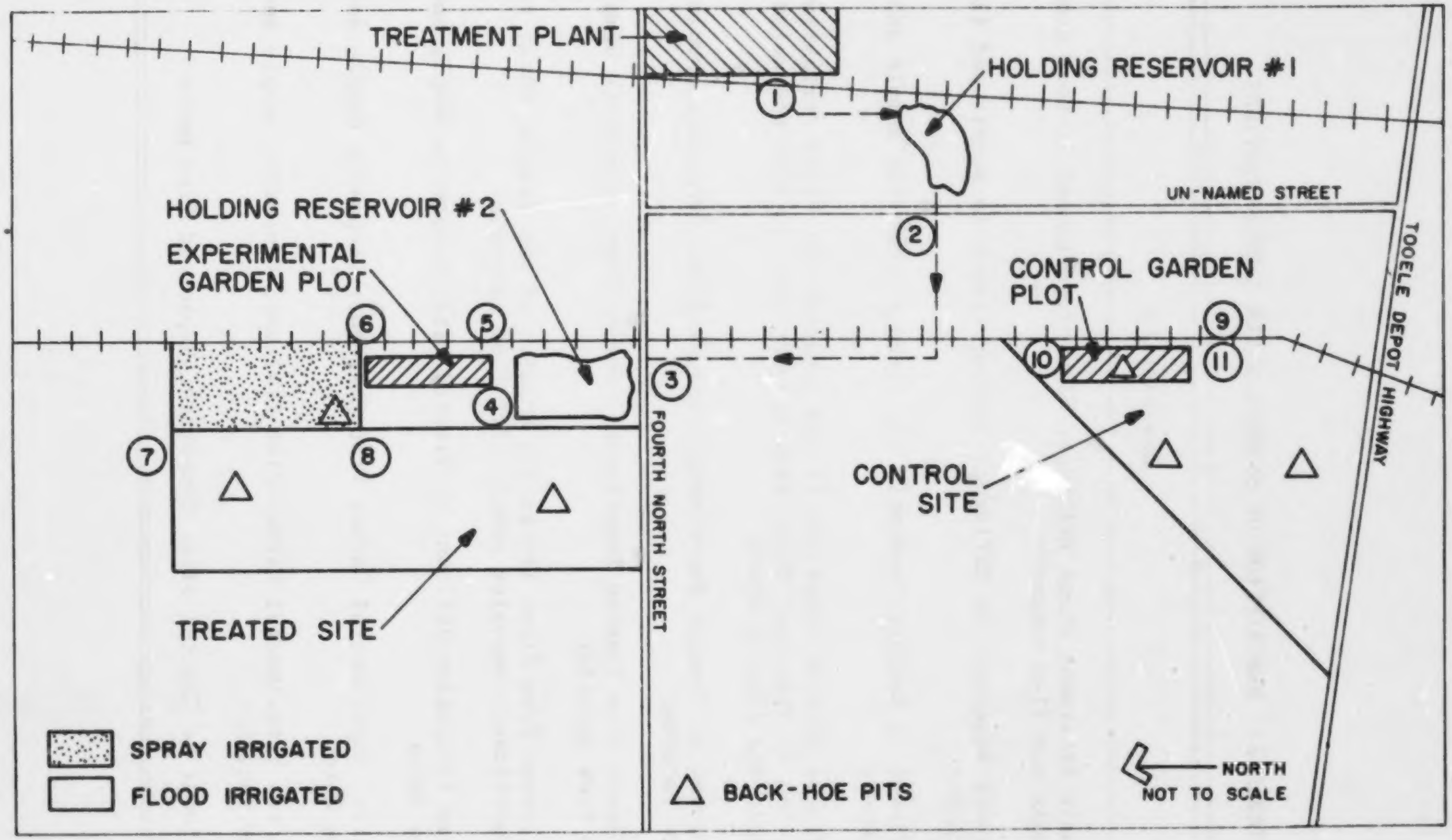

TREATMENT PLANT
HOLDING RESERVOIR #1
UN-NAMED STREET
HOLDING RESERVOIR #2
EXPERIMENTAL GARDEN PLOT
CONTROL GARDEN PLOT
TOOELE DEPOT HIGHWAY
FOURTH NORTH STREET
CONTROL SITE
TREATED SITE
1
2
3
4
5
6
7
8
9
10
11
SPRAY IRRIGATED
FLOOD IRRIGATED
BACK-HOE PITS
NORTH
NOT TO SCALE

Figure 4. Location of surface water and soil sample stations.

TABLE 2. DESCRIPTION OF SURFACE WATER SAMPLE STATIONS

Number	Description
1	Tooele Treatment Plant Effluent; Flow proportional 24-hour composite sample and flow recorder
2	Holding Reservoir #1 Effluent; 24-hour composite sample and flow recorder
3	Influent to Holding Reservoir #2; 24-hour composite sample and flow recorder
4	Effluent Holding Reservoir #2 and Influent for Flood Irrigation Portion of Treatment Site; Flow proportional 24-hour composite sample and flow recorder
5	Influent to Treated Experimental Garden Plot; Composite sample and flow recorder
6	Effluent from Treated Experimental Garden Plot; Composite sample and flow recorder
7	Tailwater from Flood Irrigation Portion of the Treated Site; Flow proportional composite sample with flow recorder
8	Spray Irrigation Influent to Treated Site; Composite sample and flow meter
9	Control Experimental Garden Plot Influent; Composite sample and flow meter
10	Control Experimental Garden Plot Effluent; Composite sample and flow recorder
11	Influent to Control Site; Composite sample and flow meter

TABLE 3. WATER QUALITY PARAMETERS MONITORED DURING THE 1976 GROWING SEASON (MAY TO NOVEMBER, 1976)

Bacteriological	Chemical	Metals	Organic
Total Coliform	Alkalinity	Aluminum	Biochemical Oxygen Demand (BOD_5)
Fecal Coliform	Calcium	Arsenic	Chemical Oxygen Demand
Fecal Streptococcus	†Chloride	Cadmium	‡Total Organic Carbon
	Hardness	Copper	Endrin
	Ammonia-Nitrogen	Chromium	Lindane
	Nitrite-Nitrogen	Iron	Methoxychlor
	Nitrate-Nitrogen	Lead	Toxaphene
	Total Kjeldahl Nitrogen	Magnesium	2,4-D
	Total Phosphorus	Manganese	2,4,5-TP (Silvex)
	Orthophosphorus	Mercury	HCB
	Total Soluble Phosphorus	Nickel	BBHC
	†Total Dissolved Solids	†Potassium	Aldane
	Suspended Solids	Silver	Oxychlor
	Volatile Suspended Solids	Sodium	Hept. epoxy
	Specific Conductance	Zinc	DDT
	†Sulfate		Organo-phosphorus
	Temperature		Seven
	pH		PCB
	Dissolved Oxygen		

† Monitored on monthly bases after 9/10/76.

‡ Eliminated from analysis due to suspended solids interference after 8/5/76.

TABLE 4. WATER QUALITY PARAMETERS MONITORED AND SAMPLE FREQUENCY DURING 1977 GROWING SEASON (MAY TO OCTOBER, 1977)

Sample Frequency	Bacteriological	Chemical	Metals	Organic
Weekly and/or during each irrigation application	Total Coliform Fecal Coliform	Ammonia-Nitrogen Nitrite-Nitrogen Nitrate-Nitrogen Total Kjeldahl Nitrogen Total Phosphorus Suspended Solids Volatile Suspended Solids Temperature pH Dissolved Oxygen		Biochemical Oxygen Demand (BOD_5)
Bi-Weekly and/or during each irrigation application (every two weeks)		Specific Conductance	Copper Mercury Lead Cadmium Chromium Zinc	Chemical Oxygen Demand
Monthly and/or during each irrigation application	Fecal Streptococcus	Alkalinity Calcium Chloride Hardness Ortho-phosphate Total Soluble Phosphorus		

TABLE 4. CONTINUED

Sample Frequency	Bacteriological	Chemical	Metals	Organic
Monthly and/or during each irrigation application		Total Dissolved Solids Sulfate		
Once at the beginning and end of the growing season and once during each irrigation application			Aluminum Arsenic Iron Magnesium Manganese Nickel Potassium Silver Sodium	
Once at the beginning and end of the growing season on Samples No. 1, 4, and 9 only				HCB BBHC Aldane Oxychlor Hept. epoxy DDT Sevin Organo-phosphorus PCB Endrin Lindane Toxaphene Methoxychlor 2,4-D 2,4,5-TP (Silvex)

addition lysimeters were installed to collect percolate. These procedures are discussed in the soil methods section.

SOIL SAMPLING

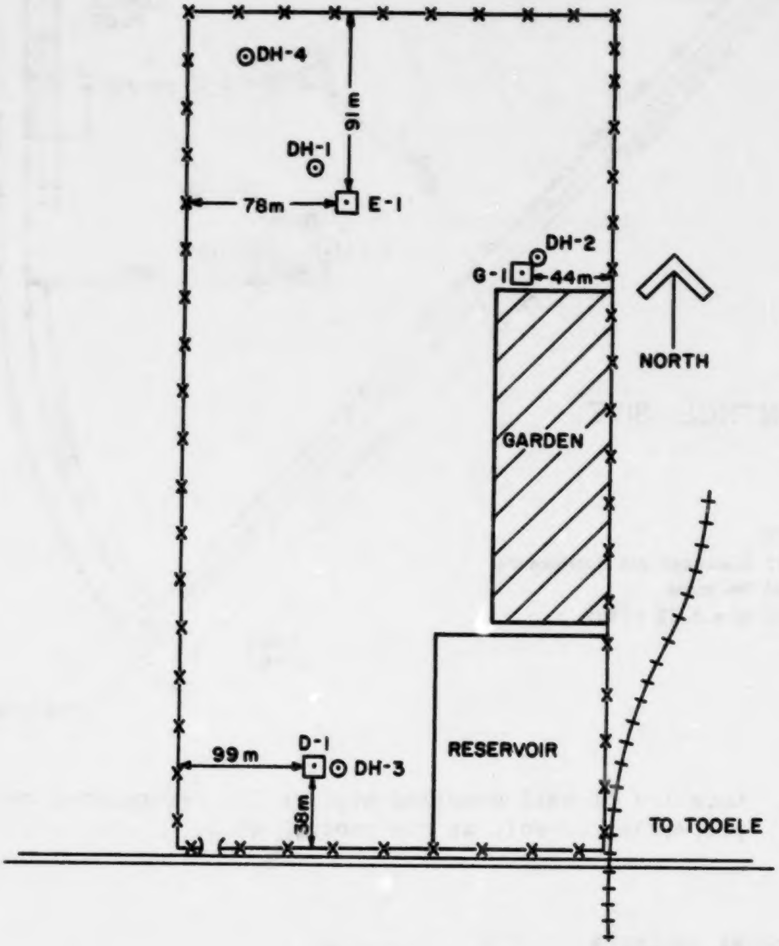
Subsurface Investigation

The field investigation included 19 test pits and seven borings at the locations shown on Figures 4, 5, and 6. Seven of the test pits were made on May 4 and 6, 1976, prior to the first irrigation for the 1976 growing season. Another six test pits were excavated on September 20, 1976, at the conclusion of the 1976 growing season. The final six pits were opened on June 30, 1977. Excavations on September 20, 1976, and June 30, 1977, were near the respective sites used the first time on May 4 and 6, 1976. A backhoe was used to excavate each test pit. All test pits were terminated at backhoe refusal, and ranged in depth from 100 cm (40 inches) to 315 cm (124 inches). These test pits were logged; disturbed samples were taken of all strata for laboratory testing to determine moisture content, Atterberg Limits and grain-size distribution. Samples were also taken at depths of 1, 3, 10, 30, 100, and 300 centimeters (0.4, 1.2, 3.0, 11.8, 39.4, and 118.1 inches) for testing in accordance with the project requirements. Additional intermediate depths were sometimes collected especially at 50 cm (19.7 inches), 200 cm (78.7 inches), and at some apparently dark-colored buried surface soil layers.

Seven borings were made from June 8, 1976, until June 15, 1976. A truck mounted rotary drill rig was used to make all borings and compressed air was used to return the drill cuttings. Six of the borings were shallow, ranging in depth from 1.7 m (5.5 ft) to 3.3 m (11 ft). One deep boring was made in the northwest corner of the treated site in an attempt to locate the groundwater table. The boring was made to a depth of 32 m (107 ft) without encountering groundwater. A perforated PVC casing was installed for long-term monitoring of the groundwater. Disturbed samples were taken with a 5 cm (2 inch) O.D. split spoon sampler driven in the manner prescribed for the standard penetration test. Thin walled Shellby tube samples were also taken; however, the soil was hard, dry and had many small rocks causing most samples to be disturbed. All samples were field classified. Selected samples from the deep boring were used to test for traces of pollutants from the applied sewage water.

Laboratory Soil Testing

Laboratory tests were performed to classify the soils and to determine the natural moisture content of all significant strata at both the treated site and control site. The laboratory tests included natural moisture content in the first collection, specific gravity, Atterberg Limits, and hydrometer analysis (grain size). Standard ASTM laboratory test procedures were employed (ASTM, 1975). The particle analysis by hydrometer was performed according to a procedure in Black et al. (1965).


DH-4
91m
DH-1
78m
E-1
DH-2
G-1
44m
NORTH
GARDEN
D-1
99m
DH-3
38m
RESERVOIR
TO TOOELE

TREATED SITE

NOTE: 1) Distances are approximate 2) Scale: 1"=200' 3) m x 3.28 = Feet

Figure 5. Location of soil sampling stations for determining the chemical properties of soil at the treated site.

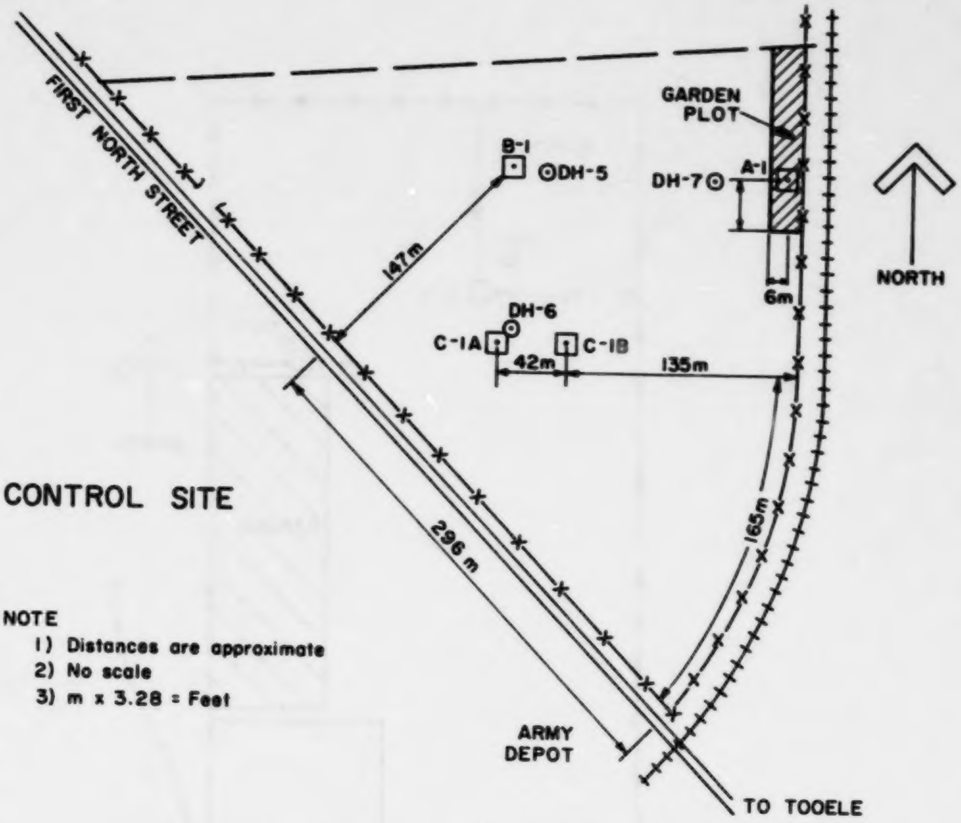

FIRST NORTH STREET
GARDEN PLOT
B-1
DH-5
DH-7
A-1
147m
6m
NORTH
DH-6
C-1A
C-1B
42m
135m
CONTROL SITE
296 m
165m
NOTE
1) Distances are approximate
2) No scale
3) m x 3.28 = Feet
ARMY DEPOT
TO TOOELE

Figure 6. Location of soil sampling station for determining the chemical properties of soil at the control site.

Soil Chemical Analyses

In the treated site, soil samples were collected for chemical analysis at locations D-1, E-1, and G-1 (Figure 5) on June 6, 1976. Subsequent samples for chemical analysis were collected within 20 m (66 ft) of the initial locations (D-1, E-1, and G-1) in September 1976 and June 1977. In the control site, soil samples were collected for chemical analysis at locations A-1, B-1, and C-1 (Figure 6) on June 6, 1976. Subsequent samples for chemical analysis were collected within 20 m (66 ft) of the initial locations (A-1, B-1, and C-1) in September 1976 and June 1977. The fraction of each soil material collected which was less than 2 mm (0.08 inches) diameter was determined by dry sieving in stainless steel sieves. All the chemical analyses were performed on these fine fractions.

Moisture constants were determined on ceramic plates using differential air pressure. These analyses were determined at the Utah Soil Testing Laboratory, Utah State University.

The various chemical analyses on the less than 2 mm (0.08 inch) fraction of the soils were performed according to "Methods of Soil Analyses" (Black et al., 1965), except as noted below.

Salinity of saturated soil paste extracts were performed using a pipette conductivity cell (Bower and Wilcox, 1965).

Total nitrogen was determined by the Kjeldahl method given by Bremner (1965a). Ammonium-nitrogen and nitrate-nitrogen were measured by the steam distillation technique described by Bremner (1965b).

Available phosphorus was measured as that extractable in either dilute acid-fluoride or in 0.5 normal sodium bicarbonate as described by Olsen and Dean (1965), except that color development involved the use of ascorbic acid rather than stannous chloride.

Trace metals were extracted by digestion in a semi-reflux manner with a HNO_3-$HClO_4$ acid mixture. After near dryness, the digest was dissolved in warm 0.5 normal HCl prior to analysis with an atomic absorption spectrophotometer.

It was known that the amount of extracted metal can be influenced somewhat by the soil-acid ratio, the temperature of digestion, and the time of digestion. The procedure initially used employed two grams of soil with 20 ml of 4:1 nitric perchloric acid mixture. By a reflux type of digestion (partial cover on the beaker) and evaporating to a low volume of acid, the metals should have been adequately extracted. However, large differences observed for measurements of some metals in the June 6, 1976, and September 20, 1976, samples indicated a need to check the procedure for soil-acid ratio and digestion time. The results are shown in Table 5. The data indicate that low metal recoveries occurred at one hour digestions and at 1:10 soil-acid ratios and highest recoveries at about three hour digestion times and 1:40 soil-acid ratios. There were some evidences of loss of lead and nickel with a four hour digestion. In selecting a procedure, a soil-acid ratio which gave less change with digestion time (more reproducible) rather than just highest extraction values was a major factor. Also, smaller soil samples have increasingly more sampling error. Thus, the samples collected on all three dates were completed using 2 g soil to 20 ml of acid mixture. Insufficient time and analytical problems caused incomplete data for rerun analyses using the 1:20 soil-acid digestions. Nevertheless, it is believed that comparisons of relative contents between treated and control site samples are still valid.

Recently, scientists in the W-124 Western Region conducting a research project studying the application of sewage sludge to soil have suggested boiling only in nitric acid. Results on a portion of these samples are shown in Table 6. Generally, nitric acid recovered slightly lower amounts of metals than the acid mixture; for safety reasons nitric acid may be a reasonable substitute for the nitric-perchloric mixture.

Chelate-soluble zinc and copper were determined by extracting 5 g of soil in 50 ml of DTPA after shaking the mixture for 30 min on a horizontal shaker adjusted for gentle shaking.

TABLE 5. STUDY OF DIGESTION OF SOIL* WITH NITRIC AND PERCHLORIC ACIDS (4:1 NITRIC-PERCHLORIC) FOR HEAVY METAL CONTENT AS AFFECTED BY SOIL:ACID RATIO AND DIGESTION TIME†

Soil Sample Size	Digestion Time	Copper	Chromium	Lead	Nickel	Zinc
g	hr	ppm				
0.5	1	31.9**	17.9	26.4	22.9	126
1.0	1	28.4	12.1	39.2	8.8	121
2.0	1	25.1	13.4	44.9	17.4	112
0.5	2	55.4	47.5	127.9	30.9	137
1.0	2	25.2	45.2	71.2	24.0	132
2.0	2	40.1	31.8	62.3	17.3	120
0.5	3	31.4	64.8	67.4	24.9	139
1.0	3	29.1	54.4	63.9	30.4	129
2.0	3	33.6	38.2	58.3	17.8	118
0.5	4	35.9	71.8	42.9	22.8	132
1.0	4	35.1	55.7	49.0	21.5	144
2.0	4	35.9	39.6	51.6	17.1	122

*Soil used was control site C, 0-2 cm depth, sampled June 1977.

**Average of two replications.

†All samples digested with 20 ml of acid mixture.

PLANTS

Field Plots

Crops--

Various economic plant species, representing forage, root, grain, and vegetable crops (Tables 7 and 8; Figures 7, 8, 9, and 10) were planted in randomized, replicated (4 replications) field plots (LeClerg, Leonard, and Clark, 1962) at the control and treated sites during the summer of 1976 and 1977. Plants at the treated site were irrigated weekly (soil soaked to a depth of 15 to 20 cm (6 to 8 inches) with wastewater from the Tooele Wastewater Treatment Plant while plants at the control site were irrigated in a similar manner with normal irrigation water.

TABLE 6. COMPARISONS OF ACID DIGESTION PROCEDURES* USING EITHER (1) NITRIC ACID ALONE OR (2) A MIXTURE OF 4 PARTS NITRIC AND 1 PART PERCHLORIC ACID

Sample analyzed and depth cm	Metal analyzed					
	Chromium		Nickel		Copper	
	nitric	mixture	nitric	mixture	nitric	mixture
	ppm	ppm	ppm	ppm	ppm	ppm
Control A, 2-4	20.3	24.4	9.2	11.2	22.0	24.7
Control B, 0-2	28.5	29.5	14.9	6.5	23.3	30.3
Control C, 2-4	28.5	30.9	15.1	15.4	20.3	24.0
Treated D, 45-55	22.9	32.6	12.9	18.2	7.6	12.2
Treated E, 2-4	26.4	12.6	16.2	14.6	21.1	20.2
Treated G, 195-205	9.4	23.4	5.9	23.1	2.3	5.5

	Metal analyzed					
	Zinc		Lead		Cadmium	
	nitric	mixture	nitric	mixture	nitric	mixture
Control A, 2-4	103.4	115.2	40.0	39.9	2.6	3.1
Control B, 0-2	115.0	132.0	41.7	46.2	3.6	1.4
Control C, 2-4	104.6	106.0	27.1	23.7	2.6	2.0
Treated D, 45-55	71.7	116.6	7.5	1.2	1.5	0.5
Treated E, 2-4	106.0	101.5	36.0	17.4	2.1	0.8
Treated G, 195-205	26.9	30.5	5.7	1.0	4.4	2.9

*2g of soil in 20 ml of acid. Digestion time 3 hours for the acid mixture; 4 hours for the nitric acid, under refluxing conditions. Tooele samples collected June 30, 1977.

Growth Measurements--

Beginning with emergence of the crop, weekly growth measurements, i.e., plant height, were made. Ten randomly selected plants within each replication were measured to the nearest centimeter.

Crop Harvest--

At the optimum harvest time for each crop, 1 meter (3 ft) of crop row was selected at random and harvested from each replication. Samples were placed in plastic bags, stored in an ice chest and returned to the lab immediately. Each sample was washed with a mild detergent solution (Dove) followed by a rinse in deionized-distilled water to remove any surface contamination. Excess water was shaken from the samples and fresh weights recorded. Samples were

TABLE 7. PLANTS AND SEED TYPE USED IN GARDEN PLOTS, 1976

Plant	Type
Alfalfa	Ranger - NK source, Nampa, Idaho
Beans	Improved Higrade - Rogers Bros. Co., Twin Falls, Idaho
Carrots	F-1 hyrid CanPak #3, Desert Seed Co., El Centro, CA
Lettuce	Great Lakes Minetto, Desert Seed Co., El Centro, CA
Onion	F-1 hybrid Amigo, Desert Seed Co., El Centro, CA
Peas	Dark Skin Perfection, Rogers Bros. Co., Twin Falls, Idaho
Potato	Norland - Griffin Farm Store, Logan, Utah
Radish	Crimson Giant, Desert Seed Co., El Centro, CA
Sweet Corn	Jubilee, Rogers Bros. Co., Twin Falls, Idaho
Tomato	Manapal - Brent Gledhill, Plant Science Dept., USU
Turnip*	Pomeranian White Globe, Desert Seed Co., El Centro, CA
Wheat	Fremont - Rulon Albrechtsen, Plant Science Dept., USU

* No data were recorded for turnip because of a mix-up in planting.

TABLE 8. PLANTS AND SEED TYPE USED IN GARDEN PLOTS, 1977

Plant	Type
Alfalfa	Ranger - NK source, Nampa, Idaho
Beans	Improved Higrade - Rogers Bros. Co., Twin Falls, ID
Carrots	F-1 hybrid CanPak #3, Desert Seed Co., El Centro, CA
Lettuce	Great Lakes Minetto, Desert Seed Co., El Centro, CA
Peas	DarkSkin Perfection, Rogers Bros. Co., Twin Falls, ID
Radish	Crimson Giant, Desert Seed Co., El Centrol, CA
Sweet Corn	Jubilee, Rogers Bros. Co., Twin Falls, ID
Wheat	Borah - Intermountain Farmers, Logan, UT

8	2	5	7	6	1	11	4	12	3	9	10	BLOCK I
3	11	8	7	2	5	12	1	10	4	6	9	II
7	2	4	12	8	6	3	11	5	1	10	9	III
12	11	1	5	2	6	9	3	8	10	7	4	IV

1. Alfalfa
2. Beans
3. Carrots
4. Lettuce
5. Onion
6. Peas
7. Potato
8. Radish
9. Sweet Corn
10. Tomato
11. Turnip
12. Wheat

Plot size = 1 m × 12 m (m × 3.28 = ft)

Figure 7. Garden plot at treated site (randomized block design), 1976.

7	11	4	12	3	1
9	8	5	11	6	10
6	12	2	7	10	8
4	2	1	9	5	3
10	5	3	1	11	4
8	6	12	10	2	7
9	5	7	4	11	6
3	1	9	2	8	12

1. Alfalfa
2. Beans
3. Carrots
4. Lettuce
5. Onion
6. Peas
7. Potato
8. Radish
9. Sweet Corn
10. Tomato
11. Turnip
12. Wheat

Plot size 2 × 12 m (m × 3.28 = ft).

Figure 8. Garden plot at control site (randomized block design), 1976.

BLOCKS	NORTH			
I	1	8	4	7
	2	6	3	5
II	8	5	1	4
	6	3	7	2
III	7	4	5	1
	3	2	8	6
IV	5	7	2	3
	4	1	6	8

1. Alfalfa
2. Beans
3. Carrots
4. Corn
5. Lettuce
6. Peas
7. Radish
8. Wheat

Each plot is 2 × 12 meters (m × 3.28 = ft).

Figure 9. Garden plot at treated site (randomized block design), 1977.

BLOCKS	NORTH			
I	1	8	4	7
	2	6	3	5
II	8	5	1	4
	6	3	7	2
III	7	4	5	1
	3	2	8	6
IV	5	7	2	3
	4	1	6	8

1. Alfalfa
2. Beans
3. Carrots
4. Corn
5. Lettuce
6. Peas
7. Radish
8. Wheat

Each plot is 2 × 12 meters (m × 3.28 = ft)

Figure 10. Garden plot at control site (randomized block design), 1977.

dried for 72 hrs at 100°C (212°F), dry weights and percent moisture determined, and then ground in a Wiley Mill (60 mesh).

Chemical Analyses

General--

The above ground samples were analyzed for cadmium, calcium, copper, iron, lead, nitrogen, phosphorus, potassium, sodium, and zinc. Chemical analyses were performed by the Soil Testing and Plant Analysis Laboratory, Utah State University, Logan, Utah. Standard solutions were prepared by suitable dilution of stock solutions (Table 9). In cases where multielement standards were needed, the concentration ranges were prepared according to Table 10.

Atomic Absorption Procedure--

The operating parameters for a commercially available atomic absorption spectrophotometer are listed in Table 11 (Jones and Isaac, 1969). The finely

TABLE 9. NORMAL CONCENTRATION RANGES FOR THE COMMONLY FOUND ELEMENTS IN SOILS AND PLANTS

Element	Soils (total)	Soils (extractable)**	Plant tissue (dry basis)
Al	2-15% as Al_2O_3	50-5,000	10-3,000 ppm (2-10,000 ppm)*
As	---	--	1 - 10 ppm
B	3 - 200 ppm	0.1 - 2	10-100 ppm (5-1,500 ppm)
Ba	0.01-0.4% as BaO	180 - 1,000	1 - 300 ppm
Ca	0.2-2.5% as CaO	100 - 15,000	0.1 - 10%
Co	1 - 40 ppm	--	0.01 - 1 ppm
Cu	2-200 ppm (1-1,000 ppm)	0.5 - 100	1 - 25 ppm
Fe	0.1 - 8% as Fe_2O_3	10 - 1,000	20 -200 ppm
K	0.1 - 4% as K_2O	50 - 4,000	0.2 - 10.0%
Li	---	--	0.1 - 10 ppm
Mg	0.1 - 2% as MgO	10 - 3,000	0.05 - 2%
Mn	0 - 0.5% as MnO	2 - 500	5 - 5,000 ppm
Mo	02. - 5 ppm	0.5 - 10	0.01 - 25 ppm
Na	0.1 - 3% as Na_2O	0 - 10,000	0.01 - 5%
P	0.05 - 0.25% as P_2O_5	0.5 - 500	0.03 - 1.0%
Rb	0.001%	--	--
S	0.05 - 0.4% as SO_3	5 - 50	0.1 - 1%
Si	65 - 95% as SiO_2	--	0.01 - 5.00%
Sr	0.02 - 0.1% as SrO	1 - 10	1 - 300 ppm
Ti	0.5 - 1.5% as TiO_2	50 - 300	--
Zn	10 - 300 ppm	1 - 100	5 - 300 ppm (5-1,500 ppm)

* ( ) indicates range in element concentrations which have been reported.

**Same units as soils (total) column.

TABLE 10. PROCEDURES FOR PREPARING 1,000 PPM STANDARD SOLUTIONS

Element	Compound or metal	Procedure to make 1 liter of each standard solution
Al	Aluminum metal	1.0000 g Al in 1:4 HCl (final HCl concentration, approx. 10%)
B	Boric acid	5.7178 g H_3BO_3 in H_2O
Ca	Calcium carbonate	2.4973 g $CaCO_3$ in 1:4 HCl (final HCl concentration approx. 0.5%)
Cr	Potassium dichromate	2.8290 g $K_2Cr_2O_7$ in H_2O
Co	Cobalt metal	1.0000 g Co in 1:8 HCl (final HCl concentration approx. 0.5%)
Cu	Copper metal	1.0000 g Cu in 1:2 HNO_3 (final HNO_3 concentration approx. 1%)
Fe	Iron metal	1.0000 g Fe in 1:2 HCl (final HCl concentration approx. 1%)
Pb	Lead nitrate	1.5982 g $Pb(NO_3)_2$ in H_2O, add 20 ml HNO_3 (final HNO_3 concentration approx. 2%)
Mg	Magnesium metal	1.0000 g Mg in 1:100 HCl (final HCl concentration approx. 0.5%)
Mn	Manganese dioxide	1.5824 g MnO_2 in concentrated HCl, evaporate to dryness, dissolve residue in H_2O
K	Potassium chloride	1.9067 g KCl in H_2O
Na	Sodium chloride	2.5421 g NaCl in H_2O
Zn	Zinc nitrate hexahydrate	4.5490 g $Zn(NO_3)_2 \cdot 5H_2O$ in H_2O

ground plant samples were placed in an 80°C (176°F) oven overnight. Approximately 1.00 ± 0.05 g of the dried plant tissue was placed in a porcelain crucible and ashed in a muffle furnace at 475-500°C (855-932°F) for 2 to 4 hrs. Ashed samples were cooled and dissolved in 5 ml of 20 percent (2 N) HCl, with slight warming to effect complete solution of the residue. Solutions were filtered through acid-washed filter paper. Samples were analyzed in a Jarrell Ash atomic absorption spectrophotometer, Model 800.

All data were subjected to standard analysis of variance and means compared by the F test (LeClerg, Leonard, and Clark, 1962).

TABLE 11. INSTRUMENT SETTINGS FOR ATOMIC ABSORPTION ANALYSIS USING HOLLOW CATHODES*

Element		Wavelength, angstroms	Wavelength setting, mμ	Grating	Silt		Source current,‡ ma	Oxidant	Fuel	Flame condition§
					No.	SBW†				
Al	Aluminum	3093	309	UV	3	2A	25	N_2O	C_2H_2	Red.
B	Boron	2497	250	UV	4	7A	30	N_2O	C_2H_2	V. Red.
Ba	Barium	5536	277	VIS	2	1.4A	25	N_2O or air	C_2H_2	Red.
Ca	Calcium	4227	211	VIS	4	14A	10	Air	C_2H_2	Stoich.
Co	Cobalt	2407	241	UV	3	2A	3	Air	C_2H_2	Oxid.
Cu	Copper	3247	325	UV	4	7A	15	Air	C_2H_2	Oxid.
Fe	Iron	2483	248	UV	3	2A	30	Air	C_2H_2	Oxid.
Hg	Mercury	2536	254	UV	5	20A	10	Air	C_2H_2	Oxid.
K	Potassium	7665	383	VIS	4	14A	12	Air	C_2H_2	Oxid.
Li	Lithium	6708	335	VIS	4	14A	15	Air	C_2H_2	Oxid.
Mg	Magnesium	2852	285	UV	4	7A	6	Air	C_2H_2	Oxid.
Mn	Manganese	2798 2801	280	UV	3	2A	20	Air	C_2H_2	Oxid.
Mo	Molybdenum	3133	313	UV	4	7A	30	N_2O or air	C_2H_2	V. Red.
Na	Sodium	5890 5896	295	VIS	4	14A	15	Air	C_2H_2	Oxid.
Ni	Nickel	2320	232	VIS	3	2A	25	Air	C_2H_2	Oxid.
Pb	Lead	2833	283	VIS	4	7A	8/30¶	Air	C_2H_2	Oxid.
Si	Silicon	2516	252	UV	3	2A	40	N_2O	C_2H_2	V. Red.
Sr	Sirontium	4607	230	VIS	3	4A	20	Air	C_2H_2	Red.
Zn	Zinc	2139	14	UV	4	7A	20	Air	C_2H_2	Oxid.

* As recommended for Perkin-Elmer Models 303, 305, or 403. Arc discharge lamps may also be used for Hg, K, and Na, although hollow cathodes are preferred.

† Spectral band width.

‡ All currents for a DC power supply. Currents are for latest Intensitron lamps. Check recommended current on lamp label.

§ Red. = reducing (fuel rich, luminous) flame; V. Red. = very reducing flame; Oxid. = oxidizing (lean, blue) flame; stoich. = stoichiometric flame (intermediate between oxidizing and reducing).

¶ Depending on type of lamp; two types available.

SECTION 5

RESULTS OF WATER QUALITY AND SOIL INVESTIGATION

PHYSICAL DESCRIPTION OF SITE

Surface

The surficial conditions at the study site are typical of pasture and farm land. There were no buildings on either site. A small water reservoir was located in the south east corner of the treated site as shown in Figure 5. The treated site is nearly flat and was used for pasture and alfalfa hay. The control site is slightly sloped and was also used for pasture and alfalfa hay. Experimental garden plots were installed at each site as part of this study at the locations shown on Figures 5 and 6.

Subsurface

A subsurface soil investigation was conducted as described in Section 4: Methods. The purpose of the investigation was to determine the soil profile and to obtain samples for laboratory testing. The test pit and boring locations are shown on Figures 5 and 6 and the test pit and boring logs are recorded in Appendix A, Figures A-1 to A-5.

In general the soil profile consists of 1 m to 2 m (3 1/2 feet to 6 1/2 feet) of silt and silty clay overlaying gravelly silt. The gravelly silt overlays sandy gravel with cobbles and in some cases the gravel is cemented. Well logs from wells near the site indicate that the gravel may be up to several hundred feet deep. The static water table in these wells is greater than 122 m (400 feet). The deep boring in the treated site showed sandy gravel and silty gravel to a depth of 33 m (107 feet) interbedded with layers up to 3 m (10 feet) thick of moist silty clay. The depth to the sandy gravel stratum at the treated site was greater than at the control site. The boring logs show that the depth to the sandy gravel stratum varies from 2.1 m to 2.5 m (7 feet to 8.3 feet) at the treated site and from 0.8 m to 2 m (2.5 feet to 6.4 feet) at the control site. In general, there were more rock fragments throughout the soil profile at the control site.

Laboratory tests were conducted on samples taken from both the treated site and control site to determine the Atterberg limits, natural moisture content and grain size distribution of the soils. These tests were used primarily to classify the soils according to their general characteristics.

Rather than taking samples on a predetermined interval, as was done for the other soil tests conducted for this study, the samples were obtained from the various strata as identified in the walls of the test pits. The test results were then used in evaluating the general soil profile. The laboratory test results are presented on Table 12. Samples obtained during the investigation of May 4 and 5, 1976 (beginning of the growing season) are indicated in Table 12 by test pit designations A, B, C, D, E, F, and G. Samples obtained during the investigation of September 20, 1976 (end of growing season) are indicated by test pit designations A′, B′, C′, D′, E′, and F′. The test pits that were made at the end of the growing season were excavated at locations immediately adjacent to those made at the beginning of the growing season. Except for changes in the natural moisture content of the soil there were no significant changes in the Atterberg limits that could be attributed to irrigation activities during the summer.

WATER QUALITY

Introduction

A summary of the water quality data collected for the entire project is reported in Table 13. A complete listing of all water quality data collected and a summary analysis of the mean, maximum, minimum, variance, and standard deviation of each parameter is contained in Appendix B.

Water quality sampling of the 34 parameters at the 11 sampling stations is described in Section 4: Methods. The 1976 sampling period began in May 1976 and continued through October 1976. The 1977 sampling periods began in May 1977 and continued through October 1977. Both sampling periods coincided with the use of the treatment plant effluent for land application. This irrigation period was representative of previous application periods and typical of the normal irrigation period practiced throughout the State of Utah and the intermountain west. During the winter months (November through April), treatment plant effluent was not applied to the land, rather the effluent was discharged to a marsh area.

The data for the 1976 growing season is not complete. A portion of the 1976 data was destroyed by an accidental fire. The study was repeated during the 1977 growing season to provide a complete data base for analysis.

Comparison of 1976 Data with 1977 Data

The 1976 data are more representative of the historical Tooele Wastewater Treatment Plant performance. After the 1976 growing season, but prior to the 1977 growing season, the Tooele Wastewater Treatment Plant was modified to include two-stage trickling filters and an additional secondary clarifier. These modifications increased the overall plant performance. The increased plant performance is indicated by lower plant effluent biochemical oxygen demand (BOD_5) concentrations and lower effluent total suspended solids concentrations (See Sample Station Number 1 in Table 13). However, the actual quality of effluent applied to the treated site (Station Number 4) did not change significantly for most parameters.

TABLE 12. SUMMARY OF PHYSICAL SOIL PROPERTIES

Test Pit	Depth	Natural Moisture Content	Atterberg Limits			USDA Classification				Unified Classification Symbol
			Plastic Limit	Liquid Limit	Plastic Index	% Sand	% Silt	% Clay	Nomenclature	
A A'	3½" - 7"	16.9 10.7	23.2 20.4	25.5 26.2	2.3 5.8	---	---	---	---	ML CL-ML
A A'	12" - 18"	16.6 9.4	20 25.8	26.4 26.0	4.4 0.2	39.5	47.5	13	Loam	CL-ML ML
A A'	36" - 42"	14.3 14.6	23.2 24.1	23.2 27.9	0 3.8	39.0	49.5	11.5	Loam	ML ML
A A'	57" - 61"	8.1 9.2	24.7 21.8	28.8 29.1	4.1 7.3					ML ML
A A'	63" - 68"	6.7 6.7	22.3 22.4	27.3 30.6	5.0 8.2					ML CL
B B'	0" - 10"	7.7 12.4	19.4 21.1	24.8 25.6	5.4 4.5					CL-ML CL-ML
B B'	15" - 20"	8.4 12.0	22.2 20.0	26.6 27.3	4.4 7.3					ML CL-ML
B B'	35" - 40"	12.2 6.8	20.7 24.2	26.8 34.2	6.1 10.0	33.5	51.5	15	Silty clay loam	CL-ML ML
B B'	53" - 60"	3.9 1.4								GW GW
B B'	90" - 93"	4.7 1.7								GW GW
C C'	10" - 15"	11.3 11.1	21.2 20.0	26.7 26.7	5.5 6.7					CL-ML CL-ML
C C'	42" - 45"	5.9 2.5								GW GW
C1	12" - 18"	17.4	22.6	28.3	5.7	24	63	13	Silty loam	ML
D D'	15" - 20"	16.5 17.2	21.1 23.0	25.9 26.7	4.8 3.7	35	52	13	Silty loam	CL-ML ML
D D'	27" - 33"	11.3 8.5								GM GM
D D'	37" - 42"	12.3 6.3								GM GM
D D'	50" - 60"	19.3 8.9	21.0 20.3	26.3 24.7	4.7 4.4					CL-ML CL-ML
D D'	66" - 70"	15.9 9.4								ML ML
D D'	80" - 85"	12.2 6.9								GM GM
D D'	110" - 114"	5.1 5.1								GW GW
E E'	20" - 25"	19.1 18.0	21.0 20.0	28.0 26.5	7.0 6.5	28	58.5	13.5	Silty loam	CL-ML CL-ML
E E'	40" - 45"	24.7 11.9	21.9 20.5	27.5 23.8	5.6 3.3					CL-ML CL
E E'	64" - 68"	10.3 18.5	22.6 19.3	30.8 26.8	8.2 7.5					CL CL
E E'	90" - 95"									GW GW
E'	120" - 124"	18.0	21.1	32.6	11.5					CL
G G'	16" - 20"	21.2 9.2	23.2 21.0	31.0 28.0	7.8 7.0	23.5	61.5	15	Silty loam	ML CL-ML
G G'	36" - 40"	16.3 1.9	20.8	22.1	1.3	44	46.5	9.5	Loam	ML
G G'	52" - 56"	22.2 5.7	21.0	25.2	4.2					CL-ML
G G'	67" - 71"	30.9 20.7	23.2 22.0	30.8 31.0	7.6 9.0					ML CL
G G'	77" - 82"	11.6 12.2	20.5 22.2	29.6 30.5	9.1 8.3					CL CL
G G'	122" - 124"	24.4 15.2	22.0 19.6	32.6 29.9	10.6 10.3					CL CL

TABLE 13. SUMMARY OF WATER QUALITY DATA COLLECTED DURING 1976 AND 1977 GROWING SEASONS

			Mean Concentration										
Sampling Station Number	Sample Description	Year	Alkalinity (mg/1)	Calcium (mg/1 $CaCO_3$)	Chloride (mg/1)	Hardness (mg/1 $CaCO_3$)	NH_3-N (mg/1)	NO_2-N (mg/1)	NO_3-N (mg/1)	TKN (mg/1)	Total Phosphorus (mg/1 P)	Total Soluble Phosphorus (mg/1 P)	Ortho Phosphate (mg/1 P)
1	Treatment plant effluent	1976 1977	249.9 234.5	231.6 246.1	139.2 147.3	271.5 259.0	6.76 2.92*	0.642 0.598	9.64 11.02	12.28 7.22*	10.97 10.98	8.80 9.35	8.13 8.85
2	Reservoir No. 1, Effluent	1976 1977	259.8 246.9	229.4 216.9	136.9 142.0	276.8 255.6	5.97 3.09*	0.681 0.770	5.49 7.67*	9.60 6.65*	9.86 10.31	8.99 8.42	8.93 8.21
3	Reservoir No. 2, Influent	1976 1977	251.1 244.9	236.6 211.2	137.4 147.5	265.2 260.0	5.05 2.52*	1.299 0.895*	5.27 7.29*	9.16 6.20*	10.48 9.99	8.84 8.56	8.45 7.84
4	Reservoir No. 2, Effluent	1976 1977	256.3 257.2	235.9 243.8	138.0 152.4*	269.5 247.9	5.61 3.60	1.000 0.835	4.89 6.71*	8.24 6.50	9.81 9.28	8.97 7.94	8.69 7.38
5	Treated site garden plot influent	1976 1977	255.8 246.8	221.9 205.3	134.3 147.1	263.3 251.9	5.95 3.27*	1.069 0.776*	5.79 8.46*	8.69 6.31*	9.46 9.59	8.75 8.84	8.41 8.56
6	Treated site garden plot effluent	1976 1977	287.6 ++	222.7 ++	139.5 ++	269.1 ++	4.76 ++	1.115 ++	5.48 ++	13.41 ++	19.90 ++	8.29 ++	8.30 ++
7	Treated site flood irrigation tail water	1976 1977	247.0 255.2	242.3 191.6	138.8 142.0	258.0 264.3	2.42 0.63	1.706 0.927*	6.08 7.04	6.14 4.69	8.77 8.56	6.83 7.27	6.66 7.00
8	Treated site spray irrigation influent	1976 1977	256.0 246.8	234.1 205.3	133.6 147.1	266.2 251.9	6.05 3.27*	0.675 0.776	5.34 8.46*	8.52 6.31*	10.17 9.59	8.98 8.84	8.63 8.56
9	Control site garden plot influent	1976 1977	201.1 197.7	176.1 146.2	21.2 22.0	224.4 179.8	0.046 0.057	0.0044 0.0143*	0.495 0.418	0.48 1.02	0.046 0.079	0.027 0.030	0.018 0.022
10	Control site garden plot influent	1976 1977	- ++	170.0 ++	18.8 ++	222.0 ++	0.091 ++	0.0071 ++	1.171 ++	7.34 ++	2.126 ++	0.084 ++	0.065 ++
11	Control site influent	1976 1977	201.1 197.7	176.1 146.2	21.2 22.0	224.4 179.8	0.046 0.057	0.0044 0.0143*	0.495 0.418	0.48 1.02	0.046 0.079	0.027 0.030	0.018 0.022

- No data
* 1976 mean is significantly different (95% level) from the 1977 mean , no * indicates no significant difference (95% level)
+ Analysis not performed in 1976
++ No runoff in 1977; limited runoff in 1976

TABLE 13. CONTINUED

Sampling Station Number	Sample Description	Year	Mean Concentration: Total Dissolved Solids (mg/l)	Total Suspended Solids (mg/l)	Volatile Suspended Solids (mg/l)	Specific Conductance (μmho/cm)	Sulfide (mg/l)	BOD_5 (mg/l)	COD (mg/l)	Temp °C	Dissolved Oxygen (mg/l)	pH (units)	Aluminum (μg/l)
1	Treatment plant effluent	1976	693.5	49.8	34.7	1090	59.2	29.0	106.1	20.0	5.9	7.4	95
		1977	636.3	31.0*	25.0	1161	62.5	16.0*	73.4*	18.6	7.0	6.8	131
2	Reservoir No. 1, Effluent	1976	701.5	22.0	14.0	1089	60.4	11.3	59.9	19.1	5.1	7.6	90
		1977	618.4	47.5	26.1	1114	66.5	17.9*	77.6	21.1	9.3	7.6	143
3	Reservoir No. 2, Influent	1976	640.0	165.0	31.2	1054	60.4	17.1	78.5	19.1	4.2	7.7	150
		1977	629.2	81.2	23.7	1116	65.0	14.7	63.8	21.1	5.5	7.5	108
4	Reservoir No. 2, Effluent	1976	656.7	30.9	16.8	1087	59.0	14.1	52.0	17.6	6.5	7.9	95
		1977	608.4	59.2*	24.9	1125	63.7	16.0	61.8	18.5	8.3	7.7	120
5	Treated site garden plot influent	1976	610.2	64.6	16.8	1113	66.8	12.1	60.1	20.7	7.5	7.6	150
		1977	618.0	18.8	14.3	1089	64.0	13.4	60.5	20.6	5.0	7.2	111
6	Treated site garden plot effluent	1976	619.6	1254.1	89.0	1106	66.5	17.2	196.8	22.3	8.2	7.8	190
		1977	++	++	++	++	++	++	++	++	++	++	++
7	Treated site flood irrigation tail water	1976	717.0	93.0	18.2	1161	61.9	12.4	62.6	21.0	5.2	8.3	*
		1977	572.0	127.4	22.9	1252	69.8	18.5	67.4	24.0	5.4	-	50
8	Treated site spray irrigation influent	1976	752.0	17.1	12.0	1102	60.6	13.9	55.5	19.6	4.6	7.7	60
		1977	618.0	18.8	14.3	1089	64.0	13.4	60.5	20.6	5.0	7.2	111
9	Control site garden plot influent	1976	253.2	2.2	1.6	497	22.7	1.6	9.53	16.3	8.1	7.4	154
		1977	649.7	5.8	2.6	456*	18.5	2.5	21.02	29.2	5.1	7.3	224
10	Control site garden plot influent	1976	326.0	-	-	476	23.3	4.2	181.4	15.0	8.6	7.0	330
		1977	++	++	++	++	++	++	++	++	++	++	++
11	Control site influent	1976	253.2	2.2	1.6	497	22.7	1.6	9.53	16.3	8.1	7.4	154
		1977	649.7	5.8	2.6	456*	18.5	2.5	21.02	29.2	5.1	7.3	224

- No data

* 1976 mean is significantly different (95% level) from the 1977 mean, no * indicates no significant difference (95% level)

+ Analysis not performed in 1976

++ No runoff in 1977; limited runoff in 1976

TABLE 13. CONTINUED

Sampling Station Number	Sample Description	Year	Cadmium (µg/l)	Chromium (µg/l)	Copper (µg/l)	Iron (µg/l)	Lead (µg/l)	Magnesium (mg/l)	Manganese (µg/l)	Mercury (µg/l)	Potassium (mg/l)	Silver (µg/l)	Sodium (mg/l)	Zinc (µg/l)
			Mean Concentration											
1	Treatment plant effluent	1976	0.2	36	23.5	32	3.5	9.7	11	8.0	10.0	<1.1	116	<33
		1977	<4.6	<12	41.4	36	<0.9	23.8*	< 7	<1.5	12.5	<6.0	139	44
2	Reservoir No. 1, Effluent	1976	0.2	28	21.0	30	2.5	11.5	10	6.4	10.2	4.2	119	23
		1977	<4.8*	<12	17.0	35	<0.9	25.5*	<12	<0.8	12.3*	<5.7	138	30
3	Reservoir No. 2, Influent	1976	0.2	4	9.5	41	3.0	6.9	16	4.2	10.2	1.1	118	<20
		1977	<4.6*	<12	<15.3	42	0.9	25.6*	< 9	<1.3	12.4*	<5.7	138*	26
4	Reservoir No. 2, Effluent	1976	0.3	6	9.0	26	3.0	8.1	15	3.8	10.6	<1.0	120	<18
		1977	<4.8*	<13	<13.1	102	<1.6	26.4*	<15	<0.7*	12.6*	<5.8	137*	20
5	Treated site garden plot influent	1976	0.3	22	13.8	56	3.2	10.1	21	8.3	10.5	<1.2	118	<24
		1977	<4.6*	<12	<42.3	25	<0.9	25.2*	10	<1.5	12.5*	<5.7	139	28
6	Treated site garden plot effluent	1976	0.3	12	11.0	28	3.0	11.3	15	5.1	11.1	1.0	122	<20
		1977	++	++	++	++	++	++	++	++	++	++	++	++
7	Treated site flood irrigation tail water	1976	*	*	*	*	*	3.7	–	3.8	11.9	*	126	20
		1977	<5.0	<17	<8.0	153	<0.9	26.3*	43	<0.2	18.7*	<6.0	141*	25
8	Treated site spray irrigation influent	1976	0.4	6	8.2	40	3.0	7.8	–	8.1	10.5	<1.0	119	<10
		1977	<4.6*	<12	<42.3	25	<0.9	25.2*	10	<1.5	12.5*	<5.7	139	28
9	Control site garden plot influent	1976	0.2	5	4.8	23	2.8	11.8	12	6.5	1.0	<1.0	18	<11
		1977	<4.3*	<11	<42.2*	230	<0.9	22.1*	< 6	<4.6	2.0	<5.5	20	21
10	Control site garden plot influent	1976	0.3	< 2	5.5	66	3.5	13.2	8	3.6	3.3	<1.0	19	<13
		1977	++	++	++	++	++	++	++	++	++	++	++	++
11	Control site influent	1976	0.2	5	4.8	23	2.8	11.8	12	6.5	1.0	<1.0	18	<11
		1977	<4.3*	<11	<12.2*	230	<0.9	22.1*	< 6	<4.6	2.0*	<5.5	20	21

(continued)

- No data
* 1976 mean is significantly different (95% level) from the 1977 mean , no * indicates no significant difference (95% level)
+ Analysis not performed in 1976
++ No runoff in 1977; limited runoff in 1976

TABLE 13. CONTINUED

Sampling Station Number	Sample Description	Year	Mean Concentration							
			Arsenic (µg/l)	Nickel (µg/l)	Total Coliform MPN No/100 ml †	Total Coliform MF No/100 ml †	Fecal Coliform MPN No/100 ml †	Fecal Coliform MF No/100 ml †	Fecal Streptococcus M-ENT No/100 ml †	Fecal Streptococcus KF No/100 ml †
1	Treatment plant effluent	1976	+	+	$<2.7\times10^5$	1.9×10^3	$<1.4\times10^3$	$<6.4\times10^1$	9.5×10^2	2.9×10^2
		1977	<1.0	<3	1.5×10^4	$>4.2\times10^3$	-	$>2.4\times10^3$	-	$<4.2\times10^2$
2	Reservoir No. 1, Effluent	1976	+	+						
		1977	<1.6	<4						
3	Reservoir No. 2, Influent	1976	+	+						
		1977	<1.6	<5						
4	Reservoir No. 2, Effluent	1976	+	+	1.8×10^5	$<2.0\times10^2$	$<9.4\times10^2$	$<2.3\times10^2$	7.1×10^2	3.3×10^2
		1977	1.8	<4	1.0×10^4	$>1.8\times10^3$	-	7.6×10^2	-	1.4×10^3
5	Treated site garden plot influent	1976	+	+						
		1977	1.6	<4						
6	Treated site garden plot effluent	1976	+	+						
		1977	++	++						
7	Treated site flood irrigation tail water	1976	+	+						
		1977	3.5	<3						
8	Treated site spray irrigation influent	1976	+	+						
		1977	1.6	<4						
9	Control site garden plot influent	1976	+	+						
		1977	14.8	<2						
10	Control site garden plot influent	1976	+	+						
		1977	++	++						
11	Control site influent	1976	+	+	8.0×10^1	$<9.4\times10^0$	$<3.2\times10^0$	$<2.0\times10^0$	5.6×10^0	8.7×10^0
		1977	14.8	<2	$<4.4\times10^0$*	$>2.0\times10^1$	-	$<0.4\times10^0$*	-	$<1.5\times10^0$

- No data
* 1976 mean is significantly different (95% level) from the 1977 mean, no * indicates no significant difference (95% level)
+ Analysis not performed in 1976
++ No runoff in 1977; limited runoff in 1976
† Geometric mean

A statistical comparison between the 1976 data and the 1977 data for 34 parameters at nine sampling stations is also summarized in Table 13. The complete statistical analysis is shown in Appendix C. A comparison of Station Number 6: Treated Site Garden Plot Effluent, and Station Number 9: Control Site Garden Plot Effluent was not possible because very little garden effluent was produced in 1976 and both garden plots were sprinkler irrigated in 1977 and thus did not produce any effluent.

The statistical analysis indicated that the treatment plant effluent (Station Number 1) during the 1977 growing season was significantly different (95 percent level) from the effluent during the 1976 growing season for only ten parameters (mostly heavy metals). Nine parameters were significantly different (95 percent level) between the 1976 and 1977 growing season at the historical point of land application (Station Number 4). There were also nine parameters which were significantly different (95 percent level) between the 1976 and 1977 growing season in the influent to the control site (Station Numbers 9 and 11).

Although statistically different, many of these differences may not be significant from a practical point of view. The importance and meaning of these differences will be discussed later in this report in those sections dealing with the specific sampling station.

Treatment Plant Performance

General--

The Tooele, Utah Wastewater Treatment Plant was composed of a 8,327 m^3/day (2.2 MGD) single stage trickling filter with anaerobic digestion until the spring of 1977. In April 1977, the plant was modified to provide high rate trickling filters (two stage) and the secondary clarifier capacity was significantly increased. The wastewater is predominantly domestic with a small fraction of commercial and light industrial wastes.

Historical Performance--

A summary of the yearly average effluent quality for the Tooele Wastewater Treatment Plant is shown in Table 14. A complete listing of available treatment plant performance data is contained in Appendix B.

The yearly average flow ranged from a low of 3191 m^3/day (0.843 MGD) in 1957 to a high of 5836 m^3/day (1.542 MGD) in 1974. During the study periods of 1976 and 1977, the average daily flow was 5648.5 m^3/day (1.492 MGD) and 2515.5 m^3/day (0.665 MGD) respectively. The 1977 average daily flow is considerably less than recorded in previous years. The reduction in flow during 1977 was due to water conservation practices resulting from a severe drought condition which occurred during 1977.

The available historical (1969-1975) average effluent biochemical oxygen demand (BOD_5) of the treatment plant ranged from a minimum value of 19 mg/l in 1973 to a maximum value of 36 mg/l in 1969. During the study period of 1976 and 1977, the average effluent BOD_5 was 29 mg/l and 16 mg/l, respectively. The lower average effluent BOD_5 during 1977 was due to the modifications to the treatment plant.

The available historical (1969-1975) average effluent suspended solids (Table 14) concentration of the treatment plant (for available records) ranged from a minimum value of 9 mg/l in 1971 to a maximum value of 23 mg/l in 1969. The average effluent suspended solids concentration of the treatment plant during the 1976 and 1977 study period was 49.8 mg/l and 31.0 mg/l, respectively. The average effluent suspended solids concentration measured during the 1976 and 1977 study period are substantially greater than the historical values. The historical values were obtained from grab samples while the values determined during the 1976 and 1977 study period were obtained from 24 hour composite samples.

In summary, the treatment plant effluent BOD_5 concentration averaged 26 mg/l and the suspended solids concentration averaged 21 mg/l from 1969 through 1977. No records were available to determine the treatment plant BOD_5 and suspended solids performance prior to 1969.

Surface Water

General--

From 1957 to 1976, water used for irrigation of the treated site originated from the Tooele Wastewater Treatment Plant and was applied to the

TABLE 14. YEARLY AVERAGE EFFLUENT QUALITY OF THE TOOELE, UTAH, WASTEWATER TREATMENT PLANT

Year	Flow m^3/day	BOD_5 mg/l	Suspended Solids mg/l
1957	3191	-	-
1958	3691	-	-
1959	3160	-	-
1960	4129	-	-
1961	3974	-	-
1962	4046	-	-
1963	4610	-	-
1964	4576	-	-
1965	4614	-	-
1966	4799	-	-
1967	5204	-	-
1968	-	-	-
1969	5204	36	23
1970	4837	33	19
1971	5462	22	9
1972	4970	26	14
1973	5193	19	9
1974	5836	27	18
1975	5693	25	20
1976	5647	29	50
1977	2515	16	31

MGD = m^3/day/3785

treated site by flood irrigation from the second reservoir (Sampling Station Number 4). Thus, the data collected at Sampling Station Number 4 can be considered representative of the historical water quality applied to the treated site.

Beginning in 1976, the treated site was sprinkler irrigated with effluent from the Tooele Treatment Plant. However, the water for the sprinkler system was conveyed to the treated site via a pipeline which originated near the outlet of the first reservoir rather than the second reservoir as in previous years. The sprinkler influent to the treated site was sampled just prior to the sprinkler header (Sampling Station Number 8). Thus, the quality of water at Sampling Station Number 8 may have an effect on the interpretation of the historical implications of soil samples collected during 1976 and 1977.

In order to determine any significant effects on the treated site caused by changing from flood irrigation to sprinkler irrigation, a portion of the treated site (see Figure 2) was maintained in a flood irrigation mode. This portion was flood irrigated from the second reservoir as in previous years.

Quantity: Treated Site--

There are no records to indicate the rate at which treated effluent had been applied to the treated site from 1957 to 1975. An interview with the owner of the farm indicated that three or four applications were made each growing season (i.e., May to October) and that no applications were made between October and May.

Measurements were made during 1976 and 1977 to determine the quantity of water applied by flood irrigation each season. This was accomplished by measuring the amount of water applied to the flood portion of the treated site. The results indicated that an average of 28.08 cm/irrigation (11.056 in/ irrigation) were applied in two irrigations during 1976 and that an average of 16.38 cm/irrigation (6.45 in/irrigation) were applied with one application during 1977. Only one flood irrigation application occurred during 1977 due to drought conditions and the desire of the farm owner to irrigate more valuable crops than those present on the treated site.

By weighting the average application rates for 1976 and 1977 and assuming that three applications are the normal mode of flood irrigation, it was determined that 60.84 cm/year (23.95 in/year) were applied to the treated site from 1957 to 1975. This application rate is relatively low in comparison to design criteria for wastewater land application systems (EPA et al., 1977). However, it should be emphasized that the Tooele land application system was designed and operated to maximize crop production not wastewater disposal. Thus, application rates are at a minimum to allow irrigation of as much land as possible rather than to dispose of as much water as possible over a small land area.

No measurable runoff water was detected from the flood irrigation treated site in 1976 and only 0.04 cm/irrigation (0.02 in/irrigation) was detected during 1977.

Beginning in 1976 and continuing in 1977, the majority of the treated site was sprinkler irrigated. The results indicated that 2.17 cm/week (0.853 in/week) were applied during 1976 and 2.72 cm/week (1.07 in/week) were applied in 1977. Employing a weighted average,and assuming 20 weeks of application per growing season, this amounts to 48.08 cm/year (18.92 in/year) which is approximately 20 percent less than that applied with flood irrigation.

Quantity: Control Site--

The control site has been sprinkler irrigated since it was first brought under cultivation in 1963. No records are available to indicate the historical irrigation application rate at the control site. Measurements made during 1976 indicated that 1.92 cm/week (0.76 in/week) were applied to the control site. In 1977, 2.41 cm/week (0.95 in/week) were applied. A total of 38.39 cm (15.11 in) was applied in 1976, and 7.24 cm/week (2.85 in/week) in 1977. The lower application in 1977 was due to the drought conditions. The control site was only irrigated for two weeks during 1977.

Using a weighted average application rate for the control site and assuming 20 weeks of applications per growing season, it was determined that an average of 39.68 cm/year (15.62 in/year) has been applied to the control site.

Quantity: Control vs. Treated--

The calculated annual application rate of the treated site during the irrigation period (1957 to 1975) was 60.84 cm (23.95 in) compared to 39.68 cm (15.62 in) for the control site. Based on these calculations, the treated site received approximately 35 percent more water annually. A portion of the difference is probably due to the method of application. Sprinkler irrigation is more efficient than flood irrigation.

A comparison of the sprinkler irrigated portion of the treated site with the control site indicates that the treated site received approximately 19 percent more water than the control site.

Quality: Treated Site--

As indicated above, historically the second reservoir (Sampling Station Number 4) served as the source of wastewater applied to the treated site. A summary of the effluent water quality from the second reservoir is reported in Table 15. A complete listing of all data collected is in Appendix B. These tables also contain water quality data for the sprinkler irrigated portion of the control plot (Sampling Station Number 8). Since sprinkler irrigation of the treated site did not begin until 1976, the data from Sampling Station Number 4 (effluent second reservoir) was used to evaluate the impact of long term application of wastewater to the land.

The biochemical oxygen demand (BOD_5) of the water applied to the treated site averaged 14.1 mg/l in 1976 and 16.0 mg/l in 1977. The treatment plant effluent averaged 29.0 mg/l in 1976 and 16.0 mg/l in 1977. The increase in treatment plant effluent quality in 1977 was due to the modification of treatment the plant. The water applied to the land averaged approximately 52 percent less BOD_5 than the treatment plant effluent. Apparently,

TABLE 15. COMPARISON OF AVERAGE ORGANIC AND INORGANIC CONCENTRATIONS OF VARIOUS PARAMETERS IN WATER APPLIED TO THE CONTROL AND TREATED SITES

Parameter, Units	Treated Site (Sampling Station No. 4)		Control Site (Sampling Station No. 11)		Treated Site Significantly Different (95% Level) From Control Site*	Ratio: Treated Site / Control Site	
	1976	1977	1976	1977		1976	1977
Alkalinity, mg/l	256.3	257.2	201.1	197.7	Yes	1.3	1.3
Calcium, mg/l	235.9	243.8	176.1	146.2	Yes	1.3	1.7
Chloride, mg/l	138.0	152.4	21.2	22.0	Yes	6.5	6.9
Hardness, mg/l	269.5	247.9	224.4	179.8	Yes	1.2	1.4
NH_3-N, mg/l	5.61	3.60	0.05	0.06	Yes	112.2	60.0
NO_2-N, mg/l	1.00	0.84	0.004	0.014	Yes	250.0	60.0
NO_3-N, mg/l	4.89	6.71	0.50	0.42	Yes	9.78	16.0
TKN, mg/l	8.24	6.50	0.48	1.02	Yes	17.2	6.4
Tot. Phosphorus, mg/l	9.81	9.28	0.05	0.08	Yes	196.2	116.0
Tot. Sol. Phos., mg/l	8.97	7.94	0.03	0.03	Yes	299.0	264.7
Ortho-P, mg/l	8.69	7.38	0.02	0.02	Yes	434.5	369.0
Tot. Dis. Solids, mg/l	656.7	608.4	253.2	272.0	Yes	2.6	2.2
Tot. Suspended Solids, mg/l	30.9	59.2	2.2	5.8	Yes	14.1	10.2
Vol. Sus. Solids, mg/l	16.8	24.9	1.6	2.6	Yes	10.5	9.6
Sp. Cond., µmhos/cm	1087	1125	497	456	Yes	497.0	2.5
Sulfate, mg/l	59.0	63.7	22.7	18.5	Yes	2.2	3.4
BOD_5, mg/l	14.1	16.0	1.6	2.5	Yes	5.6	6.4
COD, mg/l	52.0	61.8	9.53	21.0	Yes	5.6	2.9

*Comparison based on combined 1976 and 1977 data.

there is a significant reduction in BOD_5 as the effluent flows along the ditch, through the two reservoirs to the treated site. However, in 1977, although the treatment plant effluent was of a higher quality than during previous years, the BOD_5 concentration of the water actually applied to the treated site did not change significantly. Thus, it appears that the modification of the treatment plant had little effect on the organic quality of water applied to the land.

The chemical oxygen demand (COD) of the water applied to the treated site is approximately four times greater than the BOD_5 concentration. This indicates that the treatment plant effluent is relatively biologically stable prior to the land application. Nevertheless, the water does contain a significant organic fraction.

The suspended solids concentration of the water applied to the treated site averaged 30.9 mg/l in 1976 and 59.2 mg/l in 1977. These averages are significantly different at the 95 percent level. The average suspended solids concentrations of the treatment plant effluent were 49.8 mg/l in 1976 and 31.0 mg/l in 1977. These average concentrations are also significantly different at the 95 percent level. The treatment plant average effluent suspended solids concentration was greater in 1976 than in 1977, however, the water applied to the treated site had a greater suspended solids concentration in 1977 than in 1976. This is just the opposite of what might be expected.

The increase in suspended solids concentration of the water applied to the treated site in 1977 is due primarily to algal growth in the second reservoir. Because 1977 was a drought year, less water flooded into the second reservoir. As a result, the hydraulic detention time of the second reservoir was greater in 1977 than 1976, thus algal growth within the second reservoir increased.

The nutrient species (NA_3-N, NO_2-N, NO_3-N, TKN, total phosphorus, total soluable phosphorus, and ortho phosphorus) were greater than normally encountered in irrigation water, but probably less than wastewater normally employed in land application systems (see Table 15).

The geometric mean MPN total coliform count of the treatment plant effluent (Sampling Station Number 1) were $<2.7 \times 10^5$ organisms/100 ml in 1976 and 1.5×10^4 organisms/100 ml in 1977. At the point of land application (Sampling Station Number 4), the geometric mean MPN total coliform count was 1.8×10^5 organisms/100 ml in 1976 and 1.0×10^4 organisms/100 ml in 1977. Thus, coliform dieaway appears to be negligible after the effluent leaves the treatment plant even though the effluent passes through two separate holding reservoirs.

This conclusion is further supported by comparison of the fecal coliform data. The geometric mean MF fecal coliform count of the treatment plant effluent (Sampling Station Number 1) was 1.9×10^3 organisms/100 ml in 1976 and greater than 4.2×10^3 organisms/100 ml in 1977. At the point of land application (Sampling Station Number 4) the geometric mean MF coliform count was $>2.0 \times 10^2$ organisms/100 ml in 1976 and $>1.3 \times 10^3$ organisms/100 ml in 1977. Again, no significant reduction in coliform counts are observed as the effluent is transported through the earthen ditch and reservoir system to the land application site.

The geometric mean KF fecal streptococcus count of the treated plant effluent (Sampling Station Number 1) was 2.9 x 10^2 organisms/100 ml in 1976 and <4.2 x 10^2 organisms/100 ml in 1977. These values are similar to those found at the point of land application (i.e., 3.3 x 10^2 organisms/100 ml in 1976 and 1.4 x 10^3 organisms/100 ml in 1977). Thus, pathogenic organisms could still be present in the treated effluent applied to the treated site.

The average total dissolved solids concentration of the water applied to the treated site was 656.7 mg/l in 1976 and 608.4 mg/l in 1977. The average specific condition of the water applied to the treated site was 1087 μmhos/cm in 1976 and 1125 μmhos/cm in 1977. These values are typical for domestic wastewater and, although high, are acceptable for water to be used for irrigation (EPA, 1973).

The metals concentration of the water applied to the treated site were all significantly less than limiting concentrations recommended for irrigation water (EPA, 1973). Table 16 is a comparison of the average metals concentrations contrained in the water applied to the treated site and limiting values recommended for irrigation water.

The treatment plant effluent (Sampling Station Number 1) and the water applied to the treated site (Sampling Station Number 4) were analyzed three separate times for various organic compounds. The results of these analyses are reported in Table 17. In each case the concentration of pesticides and residual organisms was extremely low and of little consequence.

In summary, the water quality of the wastewater applied to the treated site is typical of a well operated municipal secondary wastewater treatment plant. The water is of significantly poorer quality than normally employed for irrigation, but is suitable for irrigation of most crops.

Quality: Control Site--

The irrigation water applied to the control site originated from a high mountain reservoir. In general, the reservoir collects runoff water from snowmelt during the spring. The watershed area is undeveloped, with recreation and cattle grazing being the primary uses. As a result, the irrigation water is of a high quality.

The quality of water applied to the control site is characterized by Sample Station Number 11. A summary of the water quality applied to the control site is presented in Table 15. A complete listing of all the data collected is contained in Appendix B.

The average biochemical oxygen demand (BOD_5) of the water applied to the control site was 1.6 mg/l in 1976 and 2.5 mg/l in 1977. There was no significant difference (95 percent level) between 1976 and 1977 average BOD_5 concentration of the applied water. This low BOD_5 concentration is

TABLE 16. COMPARISON OF AVERAGE METALS CONCENTRATIONS IN WATER APPLIED TO THE CONTROL AND TREATED SITES WITH RECOMMENDED LIMITS FOR IRRIGATION WATER

Parameter, Units	Treated Site (Sample Station No. 4)		Control Site (Sample Station No. 11)		Recommended Limit For 20 Year Use (EPA, 1973)	Treated Site Significantly Different (95% Level) From Control Site*	Ratio: Treated Site / Control Site	
	1976	1977	1976	1977			1976	1977
Aluminum, μg/l	95	120	154	224	20,000	No	0.6	0.5
Cadmium, μg/l	0.3	<4.8	0.2	<4.3	50	No	1.5	1.1
Chromium, μg/l	6	<13	5	<11	1,000	No	1.2	1.2
Copper, μg/l	9.0	<13.1	<1.8	<12.2	5,000	No	1.9	1.1
Iron, μg/l	26	102	23	23	20,000	No	1.1	4.4
Lead, μg/l	3.0	<1.6	2.8	0.9	10,000	No	1.1	1.8
Magnesium, mg/l	8.1	26.4	11.8	22.1	N.A.	No	0.7	1.2
Manganese, μg/l	15	<15	12	<6	10,000	No	1.3	2.5
Mercury, μg/l	3.8	<0.7	6.5	<4.6	N.A.	Yes	0.6	0.2
Potassium, mg/l	10.6	12.6	1.0	2.0	N.A.	Yes	10.6	6.3
Silver, μg/l	<1.0	<5.8	<1.0	<5.5	N.A.	No	1.0	1.1
Sodium, μg/l	120	137	18	20	SAR < 4-8	Yes	6.7	6.9
Zinc, μg/l	<18	20	<11	21	10,000	No	1.6	1.0
Arsenic, μg/l	-	1.8	-	14.8	2,000	Yes+	-	-
Nickel	-	<4	-	<2	2,000	No+	-	-

N.A. = Not available.
* = Comparison based on combined 1976 and 1977 data.
+ = Comparison based on 1977 data only.

in part due to the fact that the control irrigation water is piped to the control site and is not carried through an open ditch. Thus, the water is protected from organic contaminants.

The chemical oxygen demand (COD) of the applied water to the control site was 9.53 mg/l in 1976 and 21.02 mg/l in 1977. There was a significant difference (95 percent level) between the 1976 average COD concentration and the 1977 COD concentration. This difference is probable due to the poorer quality 1977 water resulting from low flows in the reservoir due to drought conditions. However, overall the COD concentration indicates a relatively high quality water.

Average suspended solids concentrations of the applied water to the control site were 2.2 mg/l in 1976 and 5.8 mg/l in 1977. Average volatile suspended solids concentrations were 1.6 mg/l and 2.6 mg/l in 1976 and 1977 respectively. These concentrations are relatively low and result from the initial high quality of the control water and the lack of suspended matter pick up due to transportation in the pipeline as compared to transport through an open earthen ditch.

TABLE 17. RESIDUAL ORGANIC CONCENTRATIONS MEASURED AT THE TREATMENT PLANT, TREATED SITE, AND CONTROL SITE

Sample	2, 4-D	2,4,5-T	HCB	Lindane	BBHC	Aldrin	Oxychlor.	Hept. Epox.	Dieldrin	DDT	Endrin	Methoxychlor.	Toxaphene	Organo-Phos.	Sevin	PCB
I. Treatment Plant Effluent (Station No. 1)																
a. Sept. 1976 (ppb)	.01			.18				<.01	.03	.02	<.01	<.05	<1	N.D.		
b. June 1977 (ppb)	.02			.06				<.01	.01	.02	<.01	.10	<1	N.D.		
c. Sept. 1977 (ppt)	.048	.005	.001	.029	.091	.031	.042	.083	.011	.153	.001	.001	N.D.	N.D.	N.D.	N.D.
Average																
II. Second Reservoir (Station No. 4)																
a. Sept. 1976 (ppb)	<.01			.12				<.01	.03	.01	<.01	<.05	<1	N.D.		
b. June 1977 (ppb)																
c. Sept. 1977 (ppt)	.011	.005	.001	.016	.068	.008	.015	.006	.001	.004	.001	.001	N.D.	N.D.	N.D.	N.D.
Average																
III. Control (Station No. 11)																
a. Sept. 1976 (ppb)	N.D.			N.D.				N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.		
b. June 1977 (ppb)	.022		.003				<.001		<.001	.004		N.D.	N.D.	N.D.		
c. Sept. 1977 (ppt)	.007	.005	.001	.001	.001	.001	.002	.002	.001	.001	.004	.001	N.D.	N.D.	N.D.	N.D.
Average																

N.D. = Not detected
ppb = Parts per billion
ppt = Parts per trillion

The geometric mean total coliform counts of the irrigation water applied to the control site were less than 100 organisms/100 ml in both 1976 and 1977. The geometric mean fecal coliform and fecal streptococcus counts were less than 10 organisms/100 ml in both 1976 and 1977. Thus, there appears to be no significant fecal or pathogenic contaminaton of the normal irrigation water.

The average total dissolved solids concentration of the applied water was 253.2 mg/l in 1976, and 272.0 mg/l in 1977. These values are typical of natural water quality in the Tooele, Utah area. The specific conductance for the applied control water was 497 µmhos/cm in 1976 and 456 µmhos/cm in 1977. The specific conductance values indicate a decrease between 1976 and 1977 while the total dissolved solids concentrations indicate an increase for the same period. This discrepancy is probably due to the limited number of total dissolved solids measurements made in 1977. As shown in Appendix B, Table B-25 there appears to be only one valid total dissolved solids value for 1977.

The average concentration of the nutrient species (NH_3-N, NO_2-N, NO_3-N, TKN, total phosphorus, total soluble phosphorus, ortho phosphorus) for 1976 and 1977 are recorded in Table 15. In general, the average concentrations of the nutrient species were less than 1 mg/l except for total Kjeldahl nitrogen which was 1.02 mg/l in 1977. These values further indicate the high quality of the water applied to the control site.

The average metals concentrations of the water applied to the control site are reported in Table 16. In each case, the average metals concentrations for both 1976 and 1977 were substantially below recommended limits for irrigation water quality. The average concentrations of aluminum in 1976 was 154 µg/l and in 1977 was 224 µg/l. These high values are a result of aluminum pipe being employed for transport of the water.

Table 17 indicates the concentration of various pesticides and residual organics contained in the water applied to the control site. During 1976, these concentrations were less than the detection limit of the analytical procedures employed (i.e., less than 0.001 ppb). However, by 1977, a few pesticide and residual organics were detected. These concentrations were substantially below levels of concern.

In summary, the water applied to the control site was very high. The water was low in organics, nutrients, metals, and pesticides. The salt concentrations (TDS) were low to moderate (EPA, 1973) and were substantially less than limiting values for irrigation water.

Quality: Treated vs Control--

A comparison of the quality of water applied to the control and treated sites is shown in Tables 15, 16, and 17. The average concentration of 22 of the parameters measured was significantly different (95 percent level, based on combining 1976 and 1977 data) between the treated site and control site. The parameters which were significantly different included BOD_5, COD, suspended solids, total dissolved solids, nutrient species, and certain inorganic species. In general, the average concentrations in the water applied to the treated site were substantially greater than those in the water applied to the control site. For example, the average BOD_5 concentrations of the treated site water was 6.4 times greater than the control site water.

In general, the average metals concentrations of the treated site water and the control site water were not significantly different (95 percent level, based on combined 1976 and 1977 data). Only the average concentrations of mercury, potassium, sodium, and arsenic were significantly different (95 percent level). The average concentration of aluminum and mercury were greater in the control site water than in the treated site water. The increased aluminum concentration in the control site water is probably due to the pipeline. Mercury concentrations, although statistically different, were not substantial.

In summary, the water applied to the treated site was of a significantly poorer quality than water applied to the control site. The treated site water had significantly higher concentrations of organics and nutrients. In general, metals concentrations of the two waters were similar.

Groundwater

A 5 cm (two inch) diameter well was drilled to a depth of 33 m (107 feet) in the northwest corner of the treated site (see Figure 5, Location DH-4) in an attempt to monitor groundwater movement and quality. No groundwater was encountered while drilling nor was groundwater observed in the well throughout the 1976 and 1977 study period.

An attempt to determine the percolating groundwater quality by installation of lysimeters and by extraction of the soil-water solution with porous cups located throughout the treated and control site was made during the 1977 growing season. The results of this phase of the study are discussed in the section on soil characteristics.

During the 1976 growing season (May to October) 56.2 cm (22.1 inches) of water was applied to the treated site. During the same period 10.7 cm (4.2 inches) of precipitation fell at the site. Thus, a total of 66.9 cm (26.3 inches) of water was applied to the treated site. During this same period the evapotranspiration was calculated (Perman combination) to be 96.3 cm (37.9 inches). At no time during the growing season did the rate of precipitation plus application of wastewater exceed the calculated evapotranspiration rate. Therefore, it appears that the applied wastewater may never percolate to the groundwater.

Runoff Water Quality

Because the treated site had been flood irrigated historically and because the flood irrigation method tends to produce a significant amount of excess surface runoff or tailwater, an attempt was made to determine the quality and quantity of the flood irrigation portion of the treated site tailwaters. In general, the amount of tailwater generated during the 1976 and 1977 growing season was insignificant.

The amount of tailwater generated during the 1976 growing season was too small to be measurable, however, water quality samples were collected. During the 1977 growing season a total of 0.0922 cm (0.036 inches) of tailwater was measured. This is probably much less tailwater than was produced on an annual basis during the past 20 years. Because 1977 was a drought year, very little tailwater was generated.

The quality of the tailwater was determined for both the 1976 and 1977 growing seasons. The average concentration for the various parameters is reported in Table 13. In general, the tailwater quality was significantly different from the applied water. The average suspended solids concentration of the tailwater is substantially greater than the applied water (applied = 30.9 to 59.2 mg/l vs. tailwater = 93.0 to 127.4 mg/l), however, this is due to erosion in the tailwater collection ditch rather than to treatment effects.

The average BOD_5 concentration of the tailwater is essentually the same as the applied water (applied = 14.1 to 16.0 mg/l vs. tailwater = 12.4 - 18.5 mg/l). The BOD_5 content of the tailwater could be a result of scour of surface detritus, erosion in the tailwater collection ditch or little organic removal associated with the overland flow of the wastewater. Kemp, 1978, reported that low BOD_5 content wastewaters are not significantly treated by overland flow land application systems.

Implications for Long Term Effects

The secondary treated manicipal effluent applied to the treated site since 1957 has been a relatively high quality water when compared to wastewater generally employed in land application systems. The biochemical oxygen demand (BOD_5) of the water is less than the secondary effluent discharge standards established for PL 92-500 (i.e., 30 mg/l vs.14.1 mg/l in 1976 and 16.0 mg/l in 1977). However the suspended solids concentration is slightly higher than the effluent discharge standard established for PL 92-500 (i.e., 30 mg/l vs. 30.9 mg/l in 1976 and 59.2 mg/l in 1977). The wastewater effluent is relatively low in metals and nutrients, however, it is relatively high in total dissolved solids (656.7 mg/l in 1976 and 608.4 mg/l in 1977).

The secondary treated municipal effluent applied to the treated site is of a much poorer quality when compared to the normal irrigation water used on the control site. The treated water has a BOD_5 concentration and a suspended solids concentration which is approximately ten times greater than the control water. The metals concentrations of both water are similar. The total dissolved solids of the treated water is about three times greater than the control water.

Although the treated water is of significantly poorer quality than the control water, it is still within acceptable water quality criteria for irrigation use. Thus, the long term effects of applying the treated wastewater effluent to the land should be greater than those for normal irrigation, but the effects should not significantly reduce crop production or the soil productivity.

SOIL CHARACTERISTICS

General

Soil samples were collected from shallow pits and the deep well drilling operation as described in Section 4: Methods. The samples were analysed for both physical and chemical characteristics. Comparisons were made between the treated and control sites to determine the long-term effects of irrigating with secondary treated municipal wastewater.

Soil Texture

Below about the top 60 to 90 cm, (24 to 35 inches) the soils were generally quite cobbly and gravelly, particularly in the control site. Many deep holes had over half of their soil material coarser than 2 mm (.08 inches) diameter (see Tables 18, 19, and 20). For example, although large cobbles and stones were not collected because some were more than 25 cm diameter (9.8 inches) the material at the 195 to 205 cm (77 to 80 inches) depth in the control site of replicate 1 was 80 percent coarse material. Hydrometer textural analysis of June 1977 samples are in Table 21. Because of the extremes in textural stratification, particularly the excessively high percentage of coarse particles in controls 2 and 3 and the deep parts of treated sites 2 and 3, in some profiles there would be a tendency for infiltrated water to drain less well than it would in a uniform textured soil. Infiltration during water application, however, was good.

In general, the control sites were higher in coarse materials and the coarse layers occurred at more shallow depths than occurred in the treated sites. This fact is explained by the difference in position of the sites on the landscape. The control site is higher on the sloped area. A greater chance for fine material deposition and deeper coverage on graded rocky slopes (Pleistocene rocky delta covered with later slope wash) from run-off occurs in the treated area because of the slightly lower position it occupies on the landscape and further distance from the flooding source of water and sediment. Treated sites also lie with less slope than control sites.

Soil Moisture

Moisture constants at field capacity (1/3 bar) and wilting point (15 bar) for the soils collected in the first sampling are shown in Table 22. The soil layers with the highest amounts of coarse materials are easily picked out by observing the low 1/3 bar values. Again only the smaller than 2 mm (0.08 inches) material was used but layers high in coarse fragments are also the highest in sand contents and lowest in clay.

The actual moisture contents of soils at the time of sampling are given in Tables 23 and 24. When these values are compared to the potential water retention values (1/3 bar) at the depths to 10 m, it is obvious that the samples in the upper 13.5 m (45 feet) were only slightly moist when collected. After an abnormally dry winter and spring (actually a drought year) these results are not unusual.

TABLE 18. WEIGHT PERCENTAGE OF SOIL MATERIAL (JUNE 1976) LARGER THAN AND SMALLER THAN 2 MM DIAMETER [+]

Soil Depth	Replication 1		Replication 2		Replication 3	
	<2 mm	>2 mm	<2 mm	>2 mm	<2 mm	>2 mm
	Control Site					
cm	%	%	%	%	%	%
0-2	100	0	88	11	88	12
2-4	99	1	76	24	83	17
9-11	99	1	80	20	88	12
18-22	100	0	83	17	--	--
28-32	93	7	90	10	67	33
45-55	97	3	92	8	--	--
70-80	91	9	80	20	--	--
95-105	93	7	80	20	40	60
195-205	--*	--	32	68	--	--
230-240	--	--	35	65	--	--
	Treated Site					
0-2	98	2	100	0	100	0
2-4	98	2	100	0	99	1
9-11	98	2	100	0	99	1
28-32	97	3	100	0	99	1
45-55	97	3	100	0	98	2
95-105	96	4	99	1	100	0
195-205	--	--	75	25	--	--
210-250	79	21	25	75	21	79
255-280	--	--	--	--	8	82
295-305	88	12	13	87	93	7

+Rocks larger than about 5 cm diameter were not collected and are not represented on these data.

*A dash means no sample was collected.

cm x 0.39 = inch

TABLE 19. WEIGHT PERCENTAGE OF SOIL MATERIAL (SEPTEMBER 1976) LARGER THAN AND SMALLER THAN 2 MM DIAMETER [+]

Soil Depth	Replication 1		Replication 2		Replication 3	
	<2 mm	>2 mm	<2 mm	>2 mm	<2 mm	>2 mm
			Control Plots			
cm	%	%	%	%	%	%
0-2	95	5	73	27	76	24
2-4	93	7	77	23	88	12
9-11	96	4	78	22	79	21
28-32	91	9	82	18	84	16
45-55	91	9	71	29	71	29
95-105	98	2	55	45	44	56
120-130	--[*]	--	--	--	25	75
140-150	25[†]	75[†]	--	--	46	54
195-205	20	80	59	41	--	--
220-230	--	--	49	51	--	--
295-305	62	38	--	--	--	--
			Effluent Treated Plots			
0-2	95	5	92	8	88	12
2-4	89	11	95	5	92	8
9-11	92	8	89	11	83	17
28-32	86	14	82	18	90	10
45-55	87	13	86	14	90	10
95-105	92	8	75	25	52	48
195-205	70	30	56	44	26	74
210-250	--	--	28	72	--	--
295-305	42	58	87	13	63	37

[+] Rocks larger than about 5 cm diameter were not collected and are not represented in these data.

[*] A dash means no sample was collected.

[†] This depth was actually 130-155 cm.

cm x 0.39 = inch

TABLE 20. WEIGHT PERCENTAGES OF SOIL MATERIAL (JUNE 30, 1977) LARGER THAN AND SMALLER THAN 2 MM DIAMETER +

Soil Depth	Replication 1		Replication 2		Replication 3	
	<2 mm	>2 mm	<2 mm	>2 mm	<2 mm	>2 mm
	Control Site					
cm	%	%	%	%	%	%
0-2	94	6	85	15	90	10
2-4	87	13	85	15	89	11
9-11	95	5	85	15	87	13
28-32	84	16	87	13	76	24
45-55	58	42	60	40	73	27
95-105	99	1	28	72	43	57
195-205	74	26	42	58	26	74
295-305	58	42	69	31	86	14
	--*	--	--	--	47	53
	Treated Site					
0-2	99	1	96	4	95	5
2-4	98	2	98	2	98	2
9-11	98	2	97	3	94	6
28-32	95	5	91	9	90	10
45-55	93	7	88	12	91	9
95-105	93	7	85	15	88	12
195-205	72	28	43	57	26	74
295-305	45	55	24	76	31	69
210-250 BL	--	--	--	--	17	83

+Rocks larger than about 5 cm diameter were not included in samples.

*A dash means no samples were collected

cm x 0.39 = inch

TABLE 21. HYDROMETER TEXTURAL ANALYSES OF THE SOIL SAMPLES MATERIAL SMALLER THAN TWO MILLIMETER DIAMETER COLLECTED FROM THE TOOELE SOIL SITES JUNE 30, 1977

Sample Site	Sample Depth	Sand	Silt	Clay	Textural class
	cm	%	%	%	
Control A (Replicate 1)	0-2	36	42	22	Loam
	2-4	39	37	24	Loam
	9-11	39	37	24	Loam
	28-32	35	36	29	Clay loam
	95-105	16	51	33	Silty clay loam
	295-305	47	36	17	Loam
	45-55	27	42	31	Clay loam
	195-205	46	31	23	Loam
Control B (Replicate 2)	0-2	32	41	27	Loam
	2-4	34	37	29	Loam
	9-11	36	35	29	Loam
	28-32	32	33	35	Clay loam
	95-105	--*	--	--	Sand*
	295-305	40	34	26	Loam
	45.50	31	31	38	Clay loam
	195-205	82	12	6	Loamy sand
Control C (Replicate 3)	0-2	34	42	24	Loam
	2-4	34	41	25	Loam
	9-11	36	36	28	Clay loam
	28-32	36	34	30	Clay loam
	95-105	29	47	24	Loam
	295-305**	NS	NS	NS	--N.S.
	45-55	29	41	30	Clay loam
	195-205	--*	--	--	Sand*
Effluent Plot D (Replicate 1)	0-2	31	40	29	Clay loam
	2-4	35	42	23	Loam
	9-11	36	38	26	Loam
	28-32	36	39	25	Loam
	95-105	40	37	23	Loam
	295-305	--*	--	--	Sand*
	45-55	36	36	28	Loam
	195-205	35	41	24	Loam

(continued)

cm x 0.39 = inch

TABLE 21. (CONT.)

Sample Site	Sample Depth	Sand	Silt	Clay	Textural class
	cm	%	%	%	
Effluent Plot E (Replicate 2)	0-2	28	44	28	Clay loam
	2-4	33	39	28	Clay loam
	9-11	35	38	27	Clay loam
	28-32	30	41	29	Clay loam
	95-105	25	40	35	Clay loam
	295-305	61	22	17	Sandy loam
	45-55	34	36	30	Clay loam
	195-205	62	26	12	Sandy loam
Effluent Plot G (Replicate 3)	0-2	31	40	29	Clay loam
	2-4	31	40	29	Clay loam
	9-11	32	37	31	Clay loam
	28-32	29	37	34	Clay loam
	95-105	28	38	34	Clay loam
	295-305	62	23	15	Sandy loam
	45-55	33	39	28	Clay loam
	195-205	67	20	13	Sandy loam
	140-175[†]	46	31	23	Loam

*Texture by feel was sand so no analysis was performed.

**No sample could be collected in field because rock prevented excavation.

[†] Very black layer, appears to be buried A1 (surface soil).

cm x 0.39 = inch

TABLE 22. MOISTURE PERCENTAGES AT FIELD CAPACITY (1/3 BAR) AND WILTING POINT (15 BARS) FOR SOIL SAMPLES TAKEN JUNE 1976

Replication 1			Replication 2			Replication 3		
Soil Depth	1/3	15	Soil Depth	1/3	15	Soil Depth	1/3 Bar	15 Bar
			Control Site					
cm	%	%	%	%	%	cm	%	%
0-2	27	10	0-2	28	13	0-2	29	13
2-4	24	11	2-4	24	10	2-4	27	12
9-11	22	10	9-11	23	10	9-11	28	12
28-32	22	10	28-32	24	11	28-32	26	14
95-105	23	7	95-105	21	11	95-105	5	3
28-32	21	9	230-240	3	2			
70-80	20	7	195-205	4	2			
145-155	23	8						
			Treated Site					
0-2	28	14	0-2	31	14	0-2	29	12
2-4	27	12	2-4	25	13	2-4	28	12
9-11	26	11	9-11	29	11	9-11	27	11
28-32	23	10	28-32	25	11	28-32	26	12
95-105	16	6	95-105	27	10	95-105	20	6
295-305	10	3	295-305	12	5	295-305	31	10
45-55	23	10	45-55	23	9	45-55	27	13
195-205	14	5	195-205	23	8	305-315LZ[†]	14	5

[†] LZ is a highly-calcareous, chalky lime zone found only in effluent treated replication 3.

cm x 0.39 = inch

TABLE 23. FIELD MOISTURE CONTENTS OF SOIL SAMPLES TAKEN JUNE 6, 1976

Replication 1		Replication 2		Replication 3	
Sample Depth	Moisture	Sample Depth	Moisture	Sample Depth	Moisture
		Control Site			
cm	%	cm	%	cm	%
0-4	16	0-4	17	0-4	10
5-10	10	4-10	13	4-10	9
28-32	10	28-32	15	28-32	10
48-52	10	48-52	13		
95-105	9	95-105	11	95-105	9
		Treated Site			
0-4	14	0-4	7	0-4	17
4-10	10	4-10	10	4-10	12
28-32	9	28-32	11	28-32	12
48-52	9	48-52	12	48-52	12
95-105	9	95-105	14	95-105	7

cm x 0.39 = inch

Mineral and Total Nitrogen

The results of analyses of ammonium and nitrate (Tables 25 and 26) are not helpful in evaluating the expected nitrogen accumulation from effluent additions. This is mostly because levels of nitrate and ammonium in soils at any one time are usually a quite small part of total nitrogen in the soil. Also, the control site has a good alfalfa crop (increases soil nitrogen) and the treated site is mostly a close-grazed pasture grass (uses up nitrogen). Any nitrogen buildup expected from the effluent additions are apparently masked by this crop variation.

The high nitrate values in the control site (replicates 1 and 2) at the end of the summer (Table 26) are possibly a result of the alfalfa at these sites. Older alfalfa roots and their nitrogen-fixing nodules plus leaf litter on the soil surface could supply a good source of organic nitrogen to be mineralized during warm weather. The contents at the end of summer were higher in nitrate (compare with June values in Table 25). This is not unusual because the sampling date was at the end of the summer in 1976. The alfalfa cover had time to initiate growth and adsorb the ammonium and nitrate in the spring. By September the plants grow little and nitrate still being formed in the warm soil accumulates.

TABLE 24. FIELD MOISTURE CONTENT OF SOIL SAMPLES TAKEN FROM THE DEEP CORE DRILLING HOLE (FIGURE 5, LOCATION DH-4) AT THE TREATED SITE DURING THE WEEK OF JUNE 14, 1976 [+]

Sample No.	Sampling depth	Moisture content 1	Moisture content 2	Moisture content Average
	(m)	(%)	(%)	(%)
1[*]	0-0.6	10	10	10
2	.6-1.2	6	6	6
5	4.5-4.9	3	3	3
7[†]	6.1-6.5	4	4	4
9[†]	7.6-8.0	7	8	8
11[†]	9.9-9.5	9	8	9
12[†]	10.6-11.1	4	5	4
14	13.6-14.9	3	2	2
16[†]	15.8-16.2	17	14	16
19[§]	18.5-19.1	17	16	16
22[†]	24.2-24.6	19	20	20
24[†]	27.3-27.7	17	16	17
26[†]	30.2-30.6	15	17	16

[+] Soils dried at 110°C for 24 hours.

[*] Full retention

[†] Split spoon sample

[§] Shelby tube, 15 inches retained

m x 3.28 = foot

TABLE 25. AVERAGE AMMONIUM-NITROGEN AND NITRATE-NITROGEN CONTENTS IN SOILS SAMPLED JUNE 1976 [+]

Soil Depth	Replication 1		Replication 2		Replication 3		Average	
	NH_4-N	NO_3-N	NH_4-N	NO_3-N	NH_4-N	NO_3-N	NH_4-N	NO_3-N
				Control Site				
cm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
0-2	6	6	11	7	5	16	7.3	9.7
2-4	7	5	9	5	4	5	6.7	5.0
9-11	6	5	3	6	3	4	4.0	5.0
28-32	13	5	4	6	5	3	7.3	4.7
45-55	6	4	7	6	--[*]	--	6.5	5.0
70-80	5	3	2	5	--	--	3.5	4.0
95-105	5	3	2	5	1	2	3.5	4.0
145-155	2	3	--	--	--	--	2.0	3.0
195-205	--	--	1	2	--	--	1.0	2.0
230-240	--	--	2	2	--	--	2.0	2.0
				Treated Site				
0-2	6	34	6	44	7	25	6.3	34.3
2-4	3	8	6	29	6	11	5.0	16.0
9-11	3	5	4	15	4	5	3.7	8.3
28-32	2	4	2	5	2	5	2.0	4.7
45-55	3	4	2	4	2	4	2.3	4.0
95-105	2	3	2	6	1	3	1.7	4.0
155-175(BL)[†]	-	-	3	6	-	-	3.0	6.0
195-205	2	3	4	6	4	4	3.3	4.3
295-305	2	3	2	4	4	4	2.7	3.7

[+] Only material less than 2 mm diameter was analyzed.

[*] A dash means no samples were collected, either because they were not part of the planned samples or because rock prevented excavation.

[†] A dark-colored layer which appears to be buried top soil.

cm x 0.39 = inch

TABLE 26. AVERAGE AMMONIUM-NITROGEN AND NITRATE-NITROGEN CONTENTS IN SOILS SAMPLED SEPTEMBER 1976 +

Soil	Replication 1		Replication 2		Replication 3		Average	
Depth	NH_4-N	NO_3-N	NH_4-N	NO_3-N	NH_4-N	NO_3-N	NH_4-N	NO_3-N
				Control Site				
cm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
0-2	3	22	8	20	2	8	4.3	16.7
2-4	1	12	2	9	2	5	1.7	8.7
9-11	2	25	3	8	2	5	2.3	12.7
28-32	3	13	2	8	0	5	1.7	8.7
45-55	2	8	2	2	1	4	1.7	4.7
95-105	0	12	2	2	0	3	0.7	5.7
195-205	2	1	1	3	--	--	1.5	2.0
295-305	2	3	--*	--	--	--	2.0	3.0
120-130	--	--	--	--	0	2	--	--
130-155	2	5	--	--	--	--	--	--
140-150	--	--	--	--	0	2	--	--
220-230	--	--	0	3	--	--	--	--
				Treated Site				
0-2	10	31	10	18	3	17	7.7	22.0
2-4	16	18	5	8	3	9	8.0	11.7
9-11	4	21	5	5	3	5	4.0	10.3
28-32	4	40	0	5	2	2	2.0	15.7
45-55	0	3	0	2	1	6	0.3	3.7
95-105	0	13	0	2	2	2	0.7	5.7
195-205	1	1	0	2	0	2	0.3	1.7
295-305	0	5	1	3	1	2	0.7	3.3
210-250	--	--	0	1	--	--	--	--

+Only material less than 2 mm diameter was analyzed.

*A dash means no samples collected, either because they were not part of the planned samples or because rock prevented excavation.

cm x 0.39 = inch

The high values in the samples from the treated site may be a result of both warm temperatures and cattle. The treated site is in a portion of the field used by grazing cattle. Thus, the treated site has more accumulation of feces and urine (sources of nitrogen). During the summer of 1976 animals grazed in the entire treated site. Nitrogen as nitrate was high in the shallow depths of all treated site samples. (See Table 25, Figures 11 and 12.) The variable nitrogen contents in the various soil samples are not related to total nitrogen contents (see Tables 27 and 28). In fact, the total nitrogen in the 0-4 cm (0-1.6 inch) depth of the control replicate 1 is lower than others, likely the result of the recent plowing on this site to prepare it for the garden study. By September, nitrogen fertilizer had been applied to the garden plot but not enough to cause the high increase in total nitrogen of replicate 1 of the control. This replicate was in the garden plot so it had been kept moist. Decomposition of plowed-under alfalfa probably produced the high nitrate.

There appears to have been a buildup of total nitrogen during the past years in the treated site (see Table 29). This measure is a total of all the nitrogen values from the first three shallow depths and the three deepest depths for two sampling dates. Since each sample was performed in duplicate this is an average of 12 analyses per depth.

The totals are lower for the control sites; the difference in totals of 465 ppm, is a 7.9 percent difference when the treated site is compared to the control site. This is a relatively small increase in nitrogen in the treated site but is equivalent to an accumulation of about 1,040 kg N per hectare (930 lbs/acre) for those 6 cm (2.4 inches) of soil in the top 11 cm. This nitrogen difference is equivalent to a difference (by accumulation) in soil humus content of about one percent, an appreciable difference.

The increase in total nitrogen in the three deepest sample layers of the heated site compared to the control site is irregular (see Figure 13). The extreme variation in amount of fine material in these deeper layers makes interpretation difficult. However, it seems evident that there is accumulation of nitrogen in the top two meters (6 feet) of soil but a definite lack of data or evidence to justify any assumption that appreciable quantities of nitrogen are moving beyond the 3 meters (10 feet) depth. Even nitrate-N measurements (Tables 27 and 28) have only 1 to 3 ppm N at these deeper depths, values which are normal in soils of the area.

The conclusion is that nitrogen is accumulating in the top 2 to 3 meters (6.5 to 10 feet) of soil but does not seem to be moving in appreciable quantities to deeper depths.

Available Phosphorus

The greatest difference chemically between the soil of the control and treated sites was found in the available phosphorus content. The normal phosphorus level considered in the Utah area to be adequate for plants is between 10 and 15 ppm. In Table 30, even the phosphorus in the control plots is adequate for most crops. However, the phosphorus content in the treated site is 5 to 6 times higher than that in the control site, even to depths of 50 cm (20 inches).

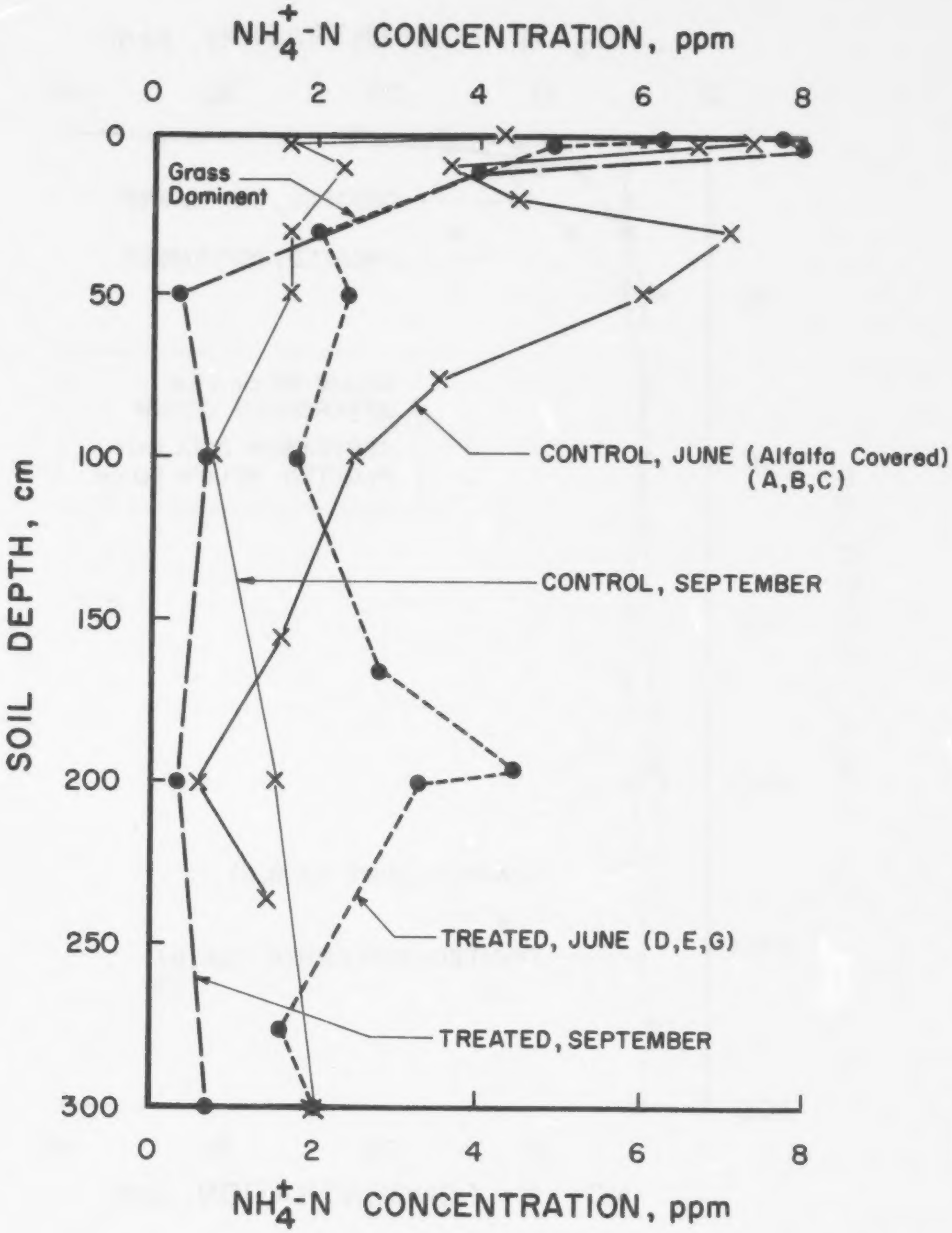


Figure 11. The NH_4-N content in control and treated site soils collected in June 1976 and in September 1976.

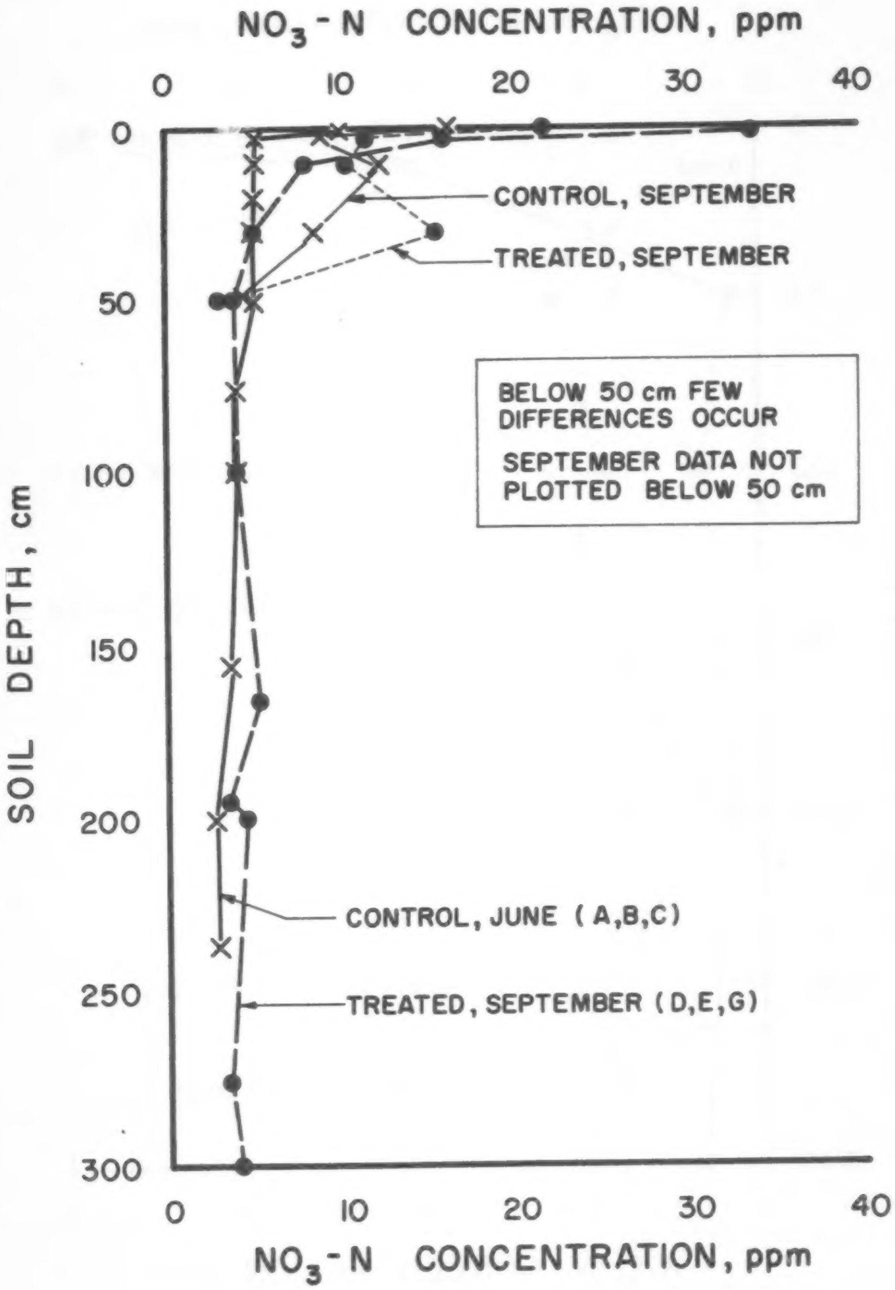


Figure 12. The NO_3-N content in control and treated site soils collected in June 1976 and September 1976.

TABLE 27. TOTAL NITROGEN (KJELDAHL) CONTENTS IN SOILS SAMPLED SEPTEMBER 1976 +

Soil Depth	Rep 1	Rep 2	Rep 3	Average
		Control Site		
cm	ppm	ppm	ppm	ppm
0-2	1,790	2,690	2,280	2,253
2-4	1,490	1,890	2,090	1,823
9-11	1,480	1,389	1,740	1,536
28-32	910	801	1,200	970
45-55	483	852	810	715
95-105	382	248	124	251
195-205	110	31	--*	71
295-305	160	--	--	160
120-130	--	--	281	281
130-155(BL)†	670	--	--	670
140-150	--	--	32	32
210-250(BL)†	--	--	--	
220-230	--	18	--	18
		Treated Site		
0-2	2,690	2,995	2,490	2,725
2-4	2,580	2,510	2,520	2,503
9-11	1,360	1,440	1,920	1,573
28-32	750	820	790	787
45-55	490	680	590	587
95-105	260	682	120	354
195-205	150	140	483	258
295-305	92	310	110	171
120-130	--	--	--	
130-155(BL)†	--	--	--	
140-150	--	--	--	
210-250(BL)†	--	660	--	660
220-230	--	--	--	

+Only less than 2 mm (0.08 in.) soil was analyzed.

*A dash means no sample taken.

†Black layer which appears to be buried surface soil.

cm x 0.39 = inch

TABLE 28. TOTAL NITROGEN (KJELDAHL) CONTENTS IN SOILS SAMPLED JUNE 1977 +

Soil Depth	Rep 1	Rep 2	Rep 3	Average
Control Site				
cm	ppm	ppm	ppm	ppm
0-2	2,900	2,760	2,370	2,680
2-4	2,300	1,980	1,810	2,030
9-11	1,580	1,260	1,480	1,440
28-32	860	860	900	870
45-55	580	880	660	710
95-105	320	90	330	250
195-205	220	40	80	110
295-305	100	110	80	100
Black Layer*	--†	--†	390	390
Treated Site				
0-2	2,500	2,500	2,520	2,510
2-4	1,710	2,120	1,940	1,920
9-11	1,420	1,590	1,380	1,460
28-32	870	860	920	880
45-55	710	740	540	660
95-105	410	500	410	440
195-205	360	310	130	270
295-305	50	80	80	70
Dark Layer*	--†	--†	1,070	1,070

+Only less than 2 mm (0.08 in.) soil was analyzed.

*Appears to be a buried dark-colored surface soil at 130 to 155 cm deep in the control replicate and 210 to 250 cm deep in the treated plot.

†A blank indicates no sample collected from the field.

cm x 0.39 = inch

TABLE 29. AVERAGE TOTAL NITROGEN (KJELDAHL) IN THE THREE TOP SAMPLING DEPTHS (0-2, 2-4, AND 9-11 CM) AND THE THREE DEEPEST SAMPLING DEPTHS (95-105, 195-205, AND 295-305 CM) FOR THE CONTROL SITE AND THE TREATED SITE IN SOILS SAMPLED IN SEPTEMBER 1976 AND IN JUNE 1977

Samples measured	Total nitrogen	
	control	treated
	ppm	ppm
Average of samples from 6 samplings, 0-2 cm	2,466	2,617
Average of samples from 6 samplings, 2-4 cm	1,925	2,211
Average of samples from 6 samplings, 9-11 cm	1,488	1,516
Total of the 3 shallow depths	5,879	6,344

Samples measured	Total nitrogen	
	control	treated
	ppm	ppm
Average of samples from 6 samplings, 95-105 cm	250	397
Average of samples from 5 samplings, 195-205 cm	96	264
Average of samples from 3 samplings, 295-305 cm	130	120
Total of the 3 deepest depths	476	781

cm x 0.39 = inch

Phosphorus values are greatly confounded by differences in soil texture and by crop cover. The one sample from 300 cm deep on the treated site which has the high phosphorus (22 ppm P) is the only deep fine-textured sample. It contains 93 percent of its bulk as particles less than 2 mm (0.08 inches) diameter. Another complicating factor is the feeding characteristics of the cover plants. Alfalfa is a known deep-rooted crop and heavy feeder on phosphorus; grasses are shallow-rooted and poorer extractors of phosphorus. The alfalfa on the control site may keep "available P," which this procedure measures, quite low. In contrast, the grass mixture on the treated site would not use as much phosphorus.

The phosphorus in the top 50 cm (20 inches) is probably an accumulation from application sources, the most important source being the wastewater effluent. Animal manures may be an additional source. Figure 14 depicts the changes with depth which occur.

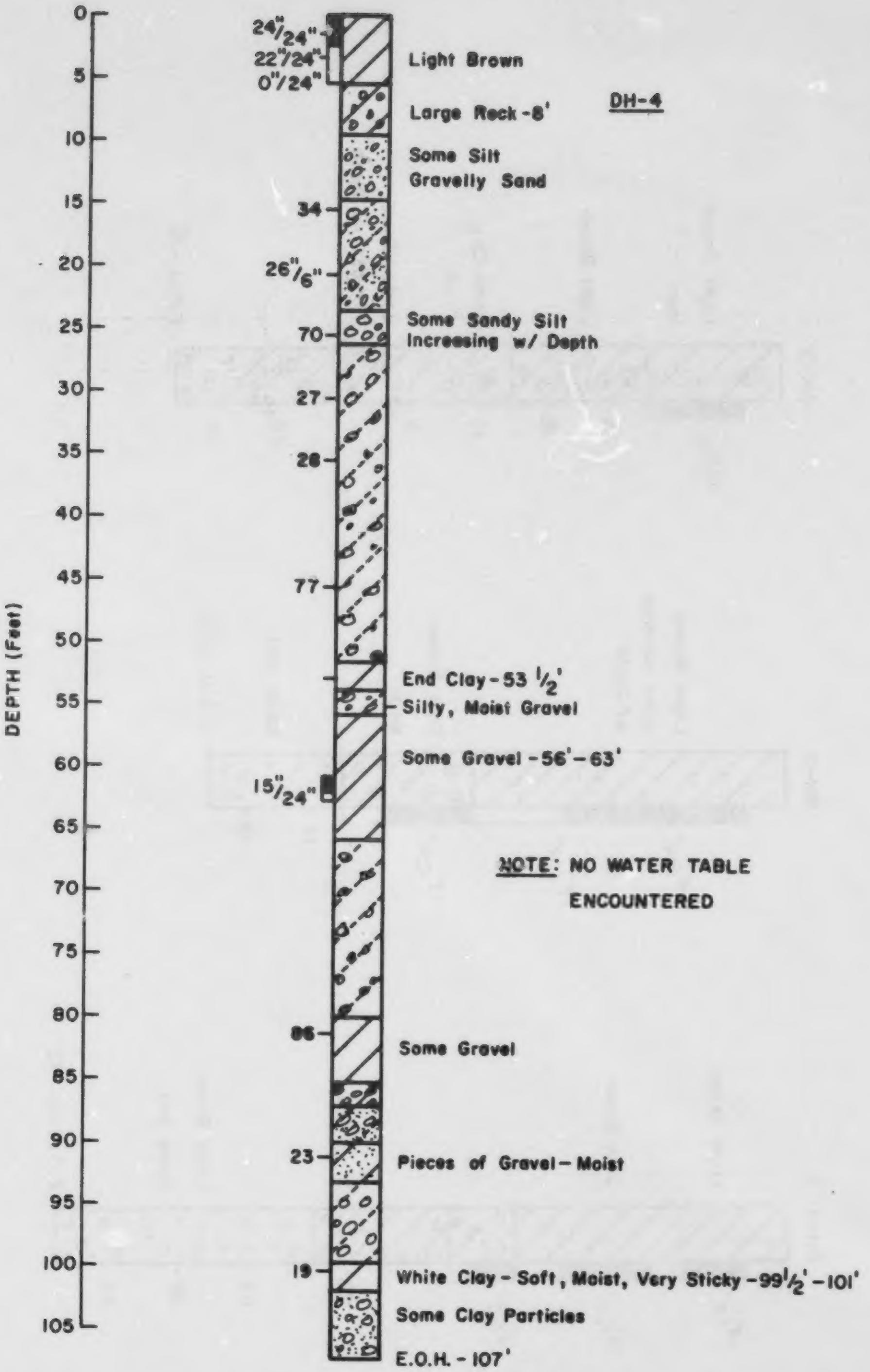

DEPTH (Feet)
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
95
100
105
24"/24"
22"/24"
0"/24"
34
26"/6"
70
27
28
77
15"/24"
86
23
19
Light Brown
DH-4
Large Rock-8'
Some Silt
Gravelly Sand
Some Sandy Silt
Increasing w/ Depth
End Clay-53 1/2'
Silty, Moist Gravel
Some Gravel-56'-63'
NOTE: NO WATER TABLE
ENCOUNTERED
Some Gravel
Pieces of Gravel-Moist
White Clay-Soft, Moist, Very Sticky-99 1/2'-101'
Some Clay Particles
E.O.H.-107'

Figure A-4. Boring log for deep boring at the treated site.

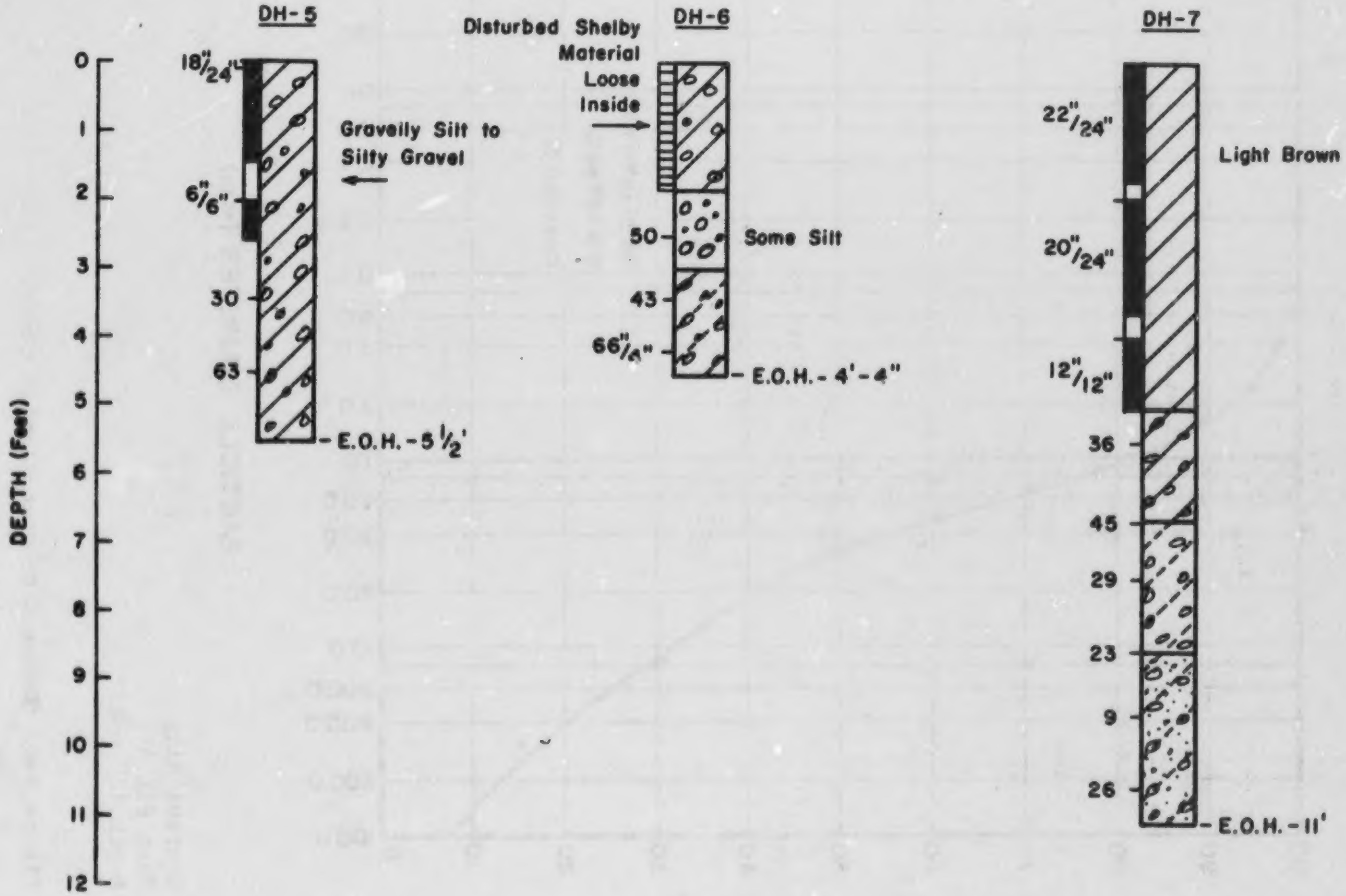
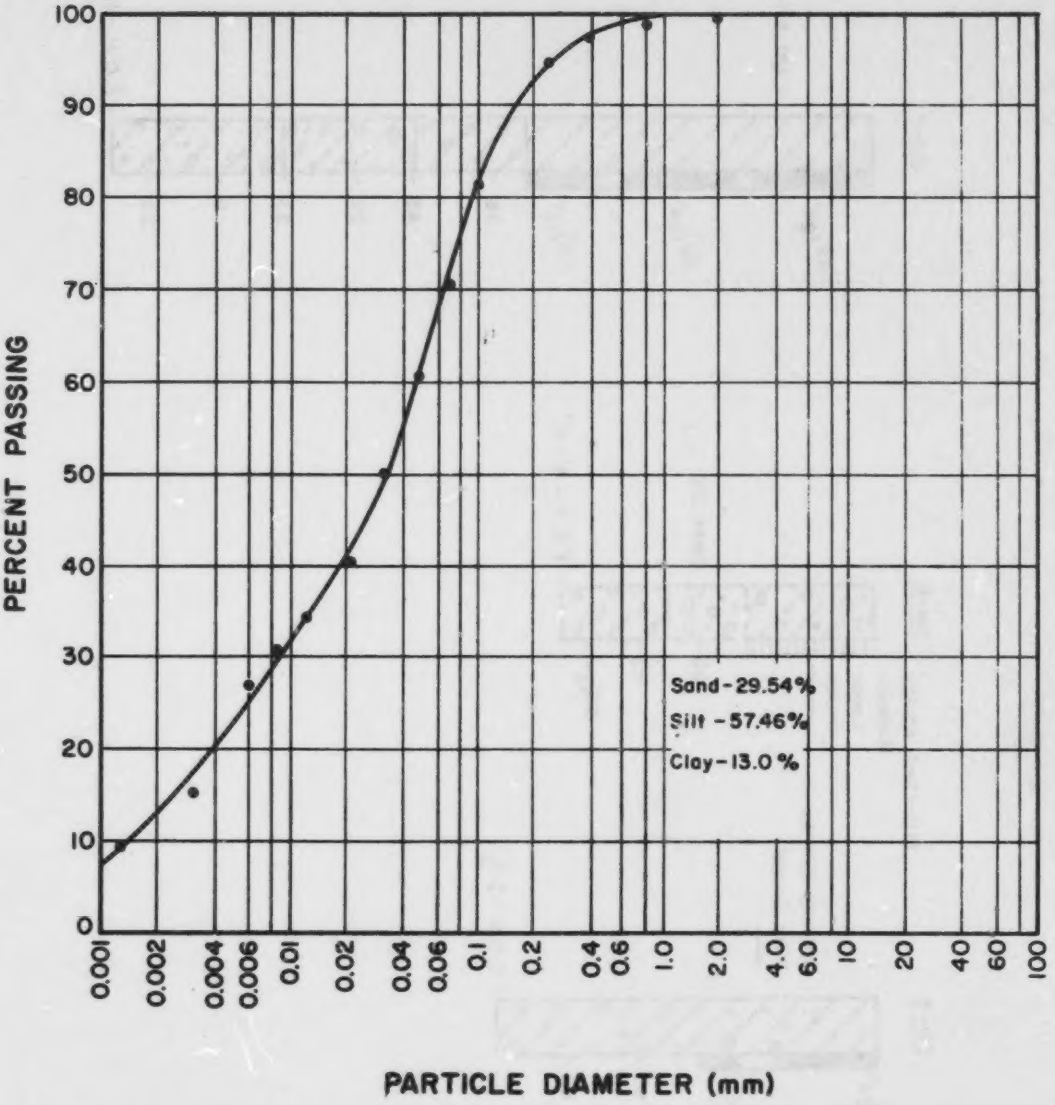
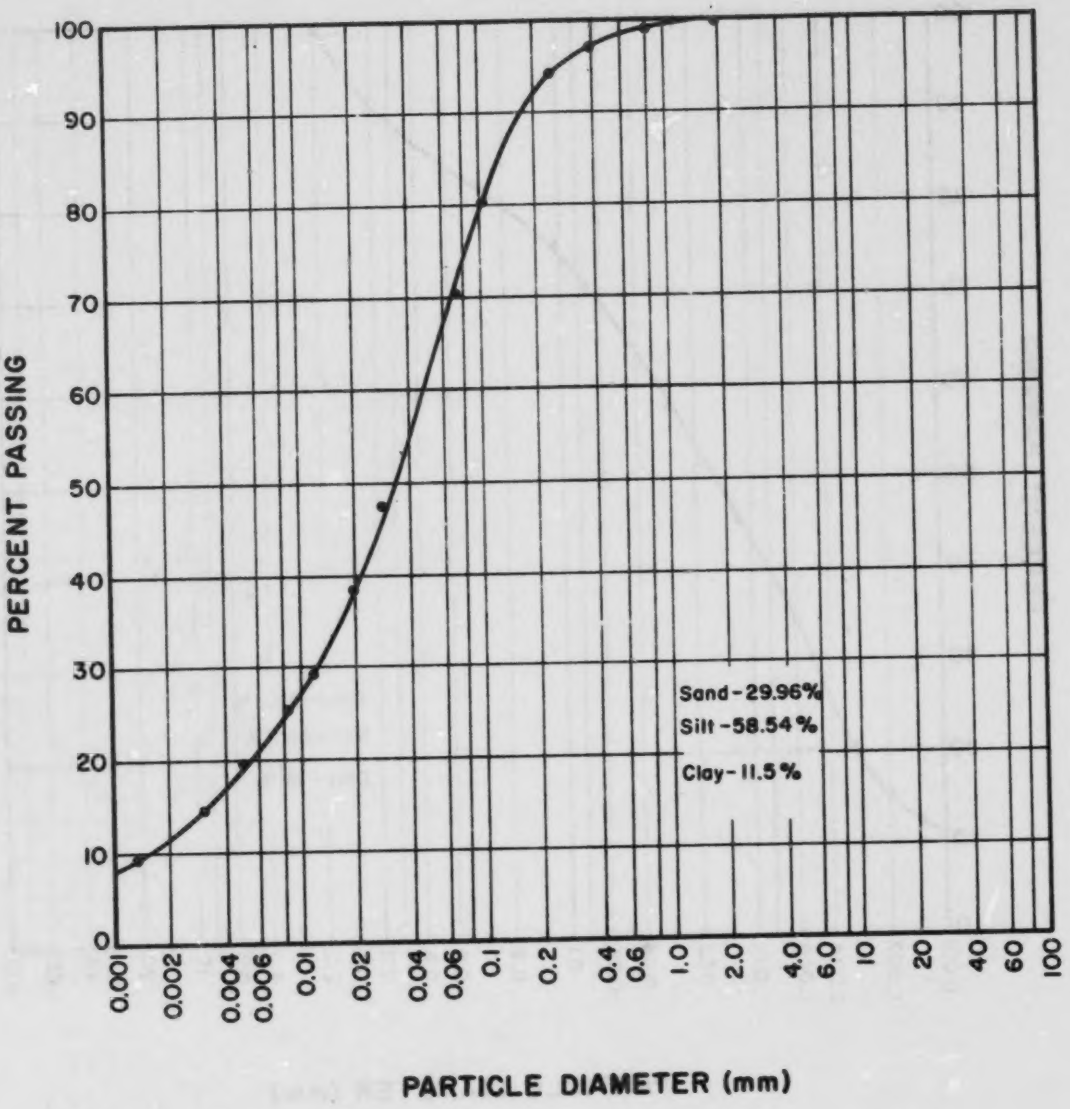

DH-5
DH-6
DH-7
DEPTH (Feet)
0
1
2
3
4
5
6
7
8
9
10
11
12
18"/24"
6"/6"
30
63
Gravelly Silt to Silty Gravel
E.O.H. - 5 1/2'
Disturbed Shelby Material Loose Inside
50
43
66"/6"
Some Silt
E.O.H. - 4'-4"
22"/24"
20"/24"
12"/12"
36
45
29
23
9
26
Light Brown
E.O.H. - 11'

Figure A-5. Boring logs for the control site.



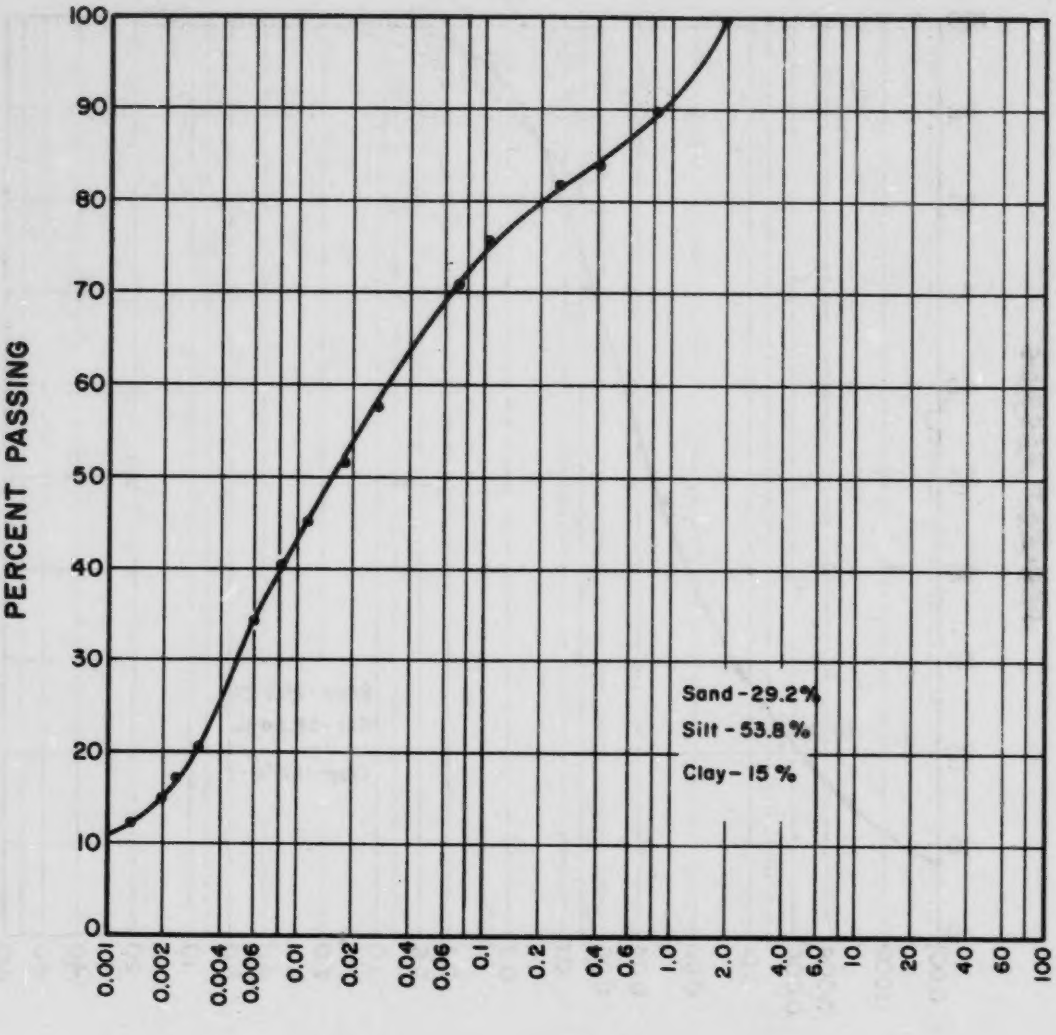
Control Site
Test Pit A
Depth 12" - 18"

Figure A-6. Grain size distribution curve.



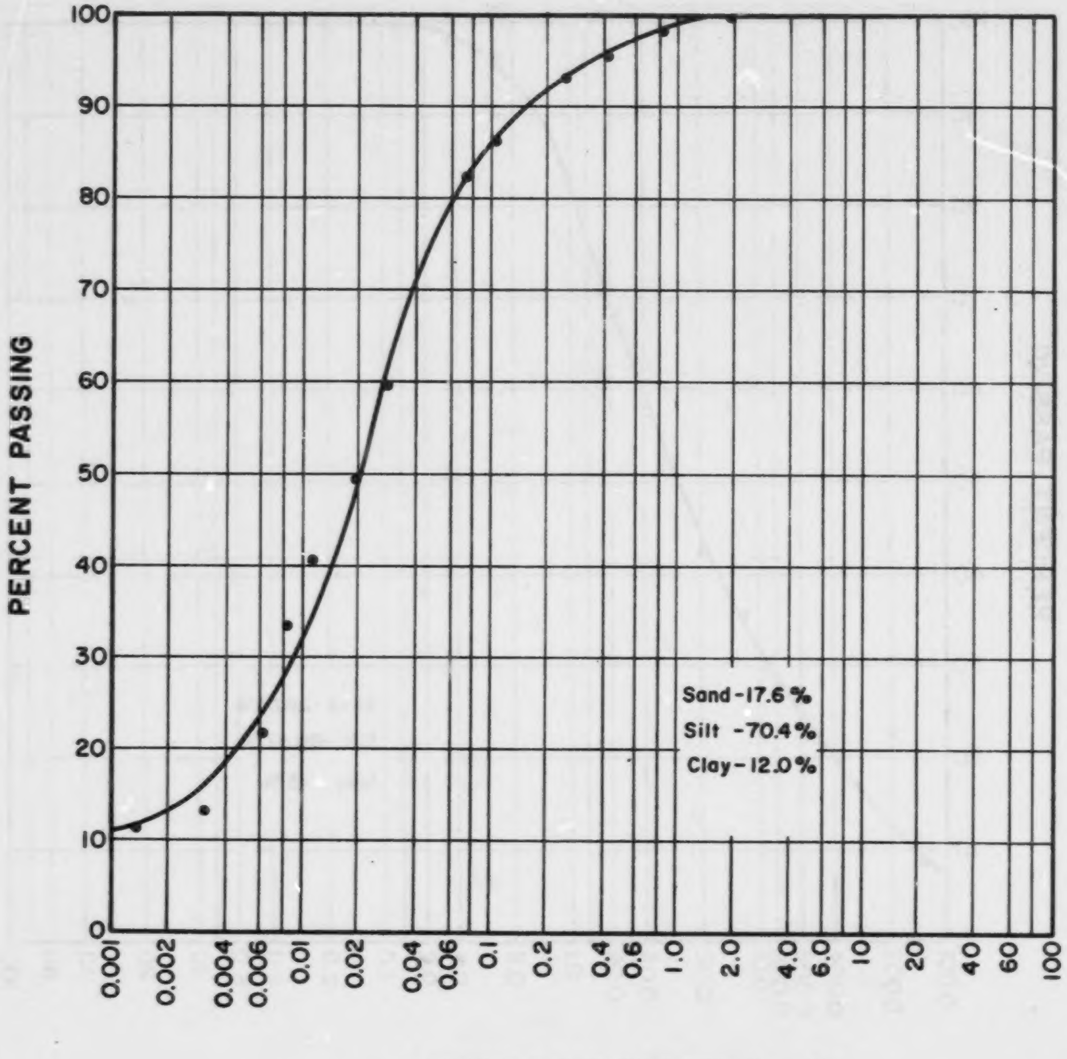
Control Site
Test Pit A
Depth 36" - 42"

Figure A-7. Grain size distribution curve.



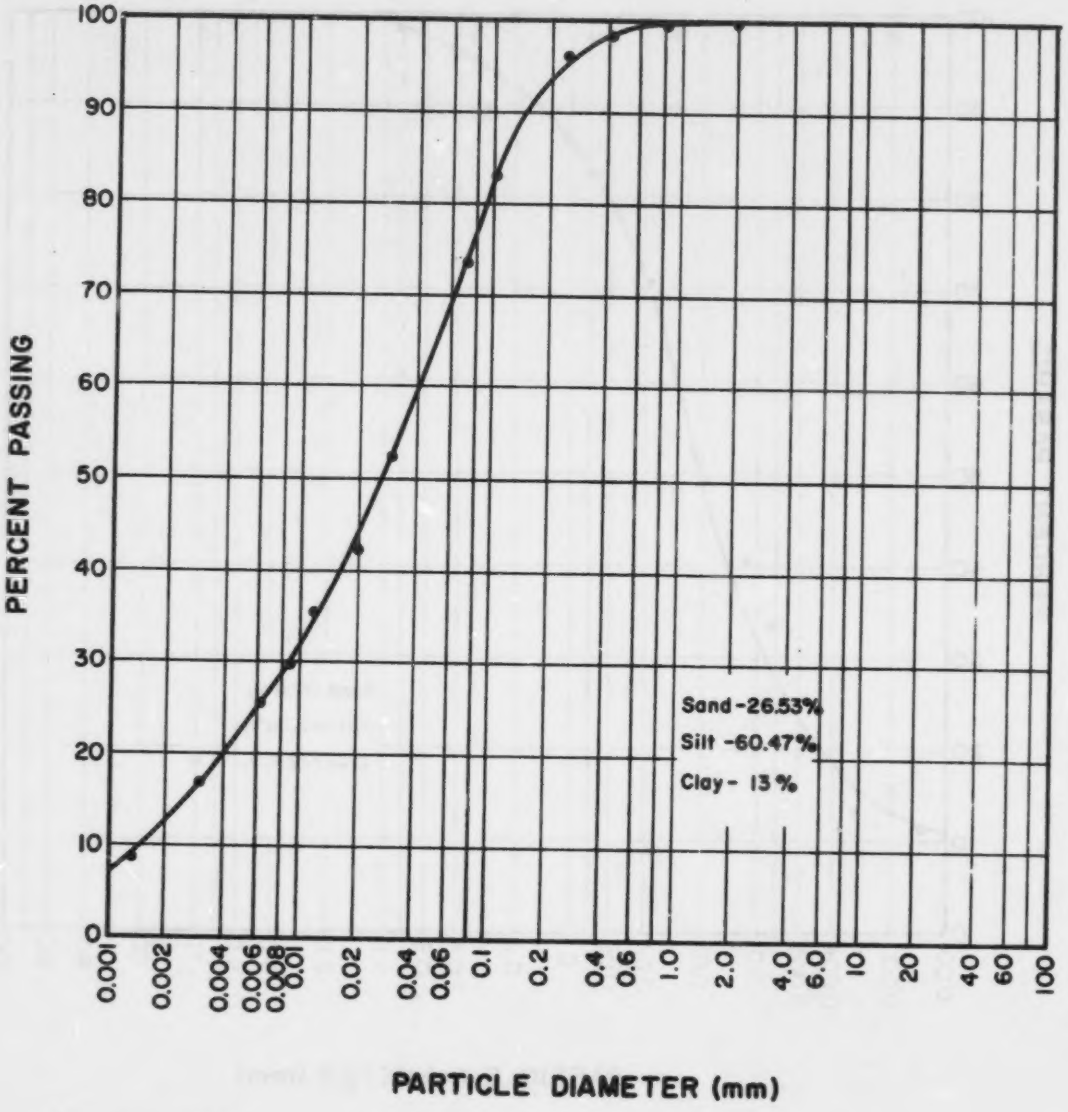
Control Site
Test Pit B
Depth 35" - 40"

Figure A-8. Grain size distribution curve.



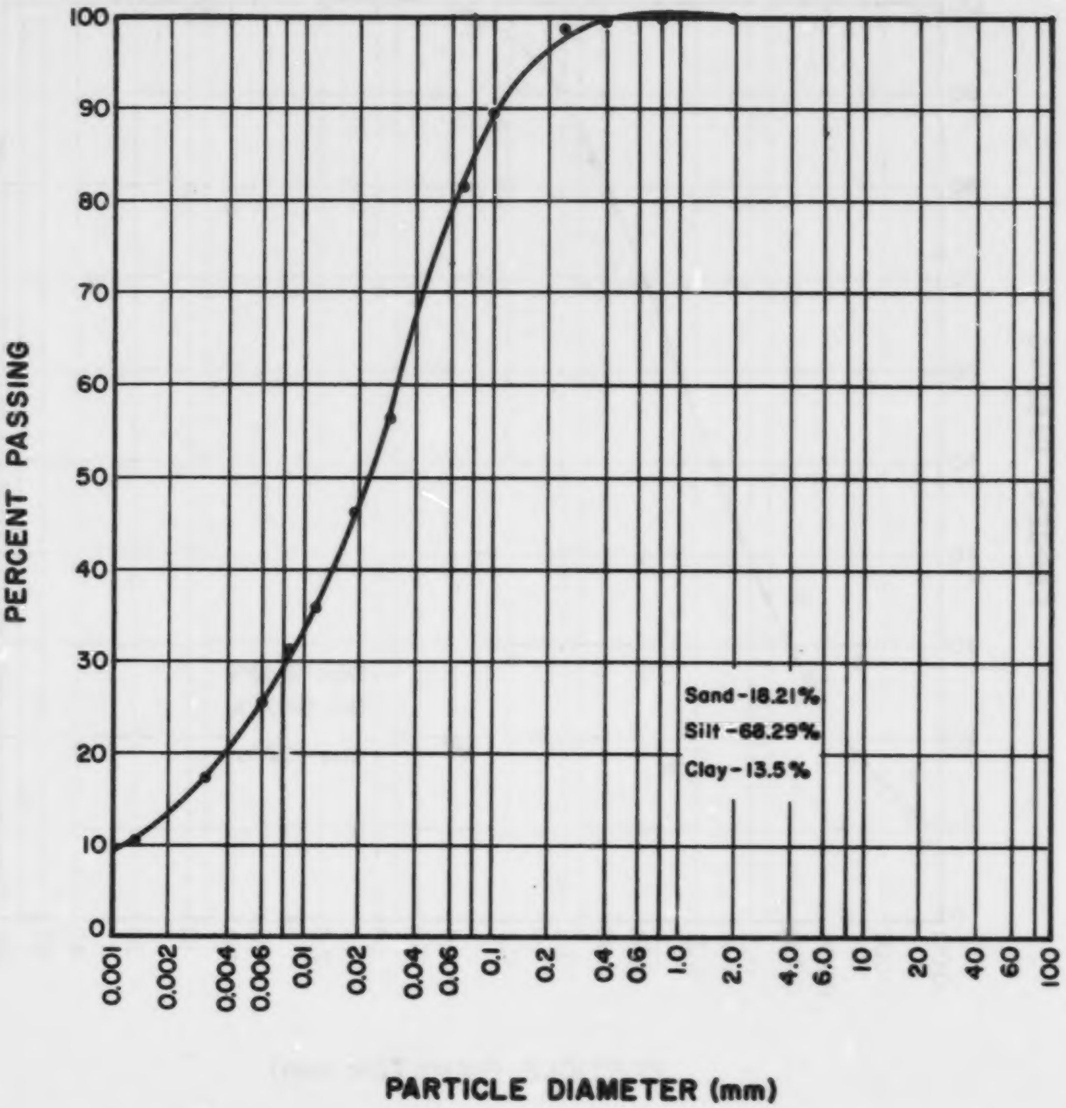
Control Site
Test Pit C
Depth 42" - 45"

Figure A-9. Grain size distribution curve.



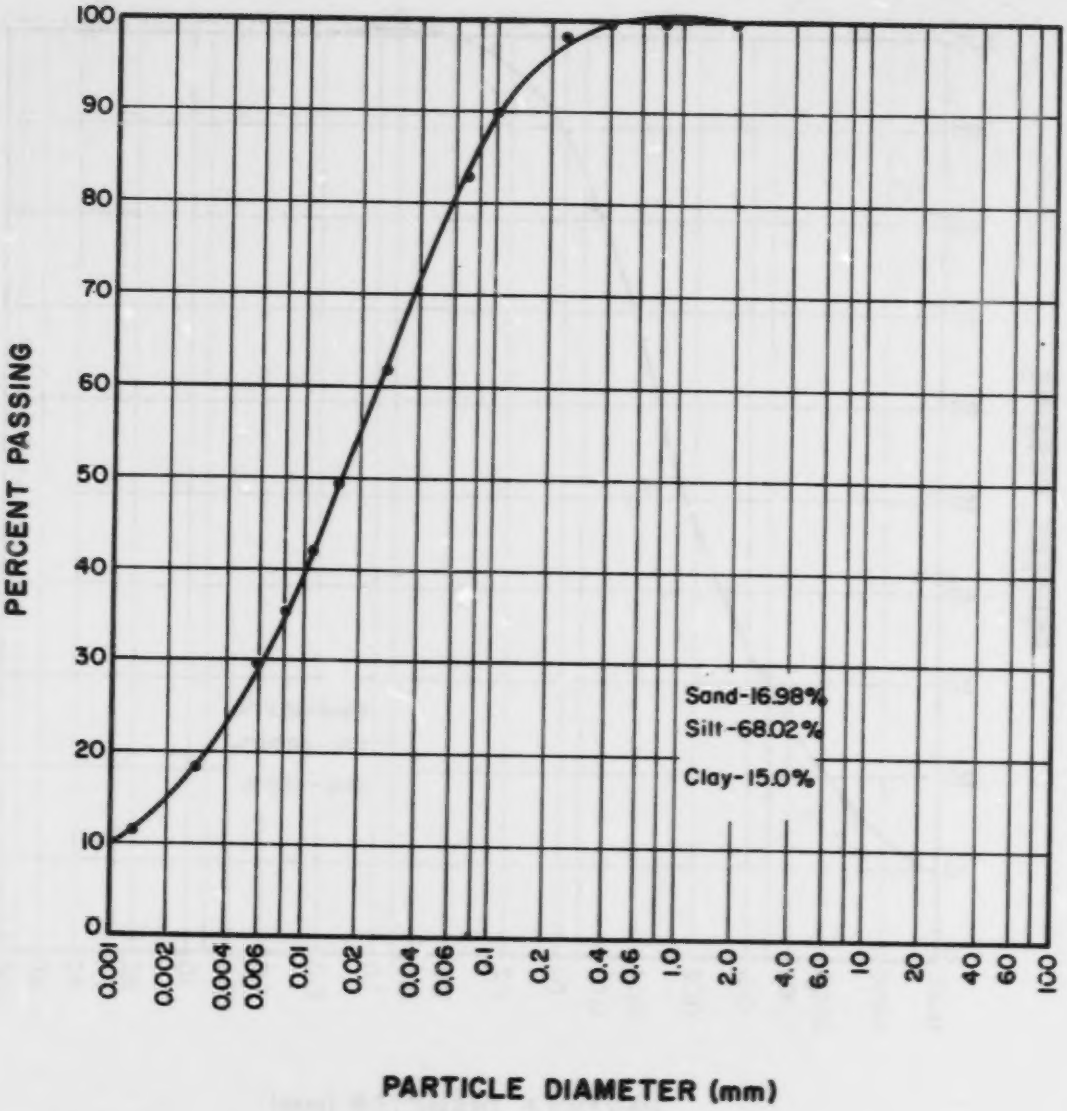
Treatment Site
Test Pit D
Depth 15" - 20"

Figure A-10. Grain size distribution curve.



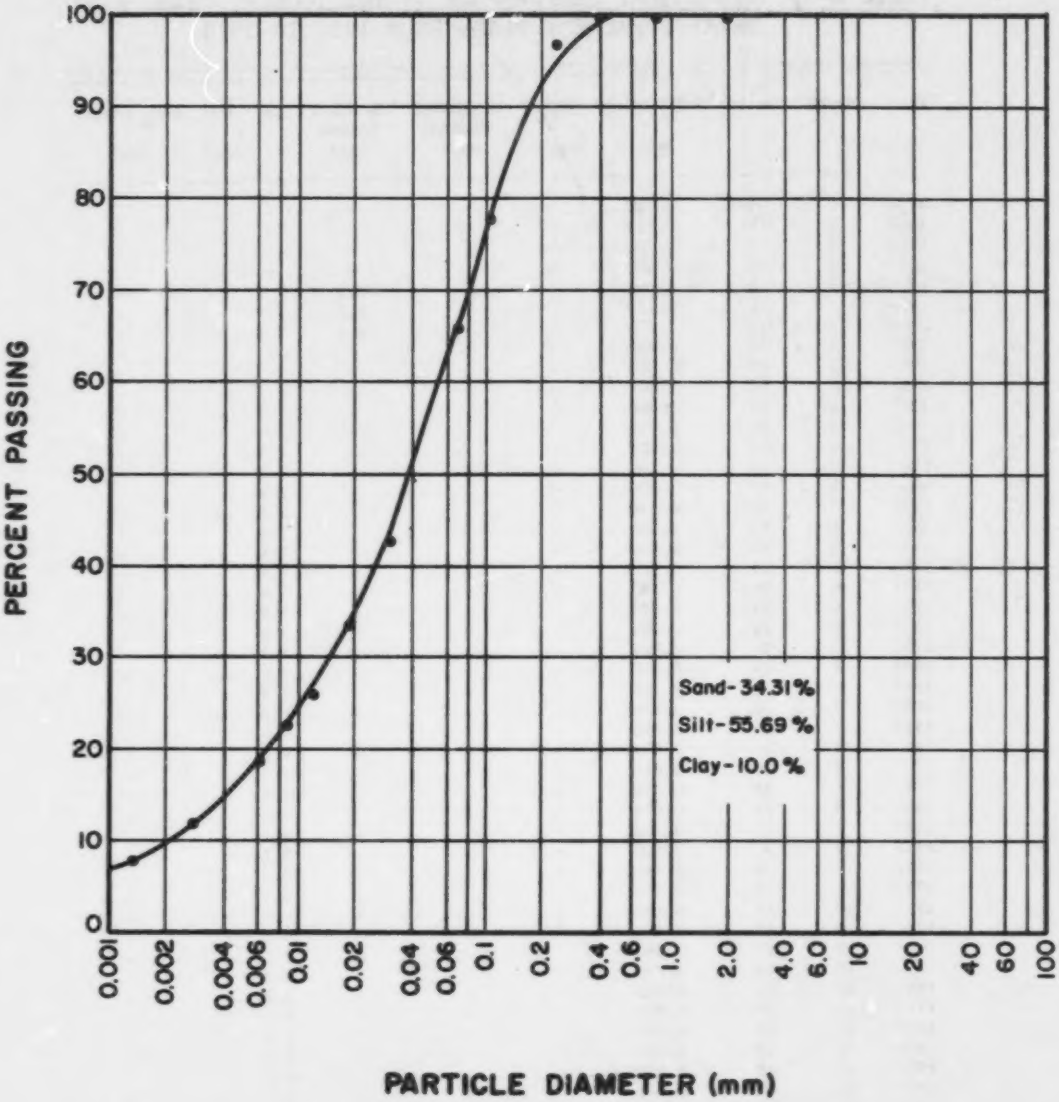
Treatment Site
Test Pit E
Depth 20" - 25"

Figure A-11. Grain size distribution curve.



Treatment Site
Test Pit G
Depth 16" - 20"

Figure A-12. Grain size distribution curve.



Treatment Site
Test Pit G
Depth 36" - 40"

Figure A-13. Grain size distribution curve.

APPENDIX B

WATER QUALITY DATA

TABLE B-1. HISTORICAL PERFORMANCE OF THE TOOELE, UTAH, WASTEWATER TREATMENT PLANT FROM 1957 TO 1975

Year	Month	Week	Daily Flow MGD	BOD_5 mg/l	Suspended Solids mg/l	Settled Solids mg/l	pH	DO mg/l	BOD_5 Solids mg/l
1957	2	5	0.850	-	-	-	-	-	-
1957	2	6	0.850	-	-	-	-	-	-
1957	2	7	0.760	-	-	-	-	-	-
1957	2	8	0.690	-	-	-	-	-	-
1957	3	9	0.790	-	-	0.5	7.7	-	-
1957	3	10	0.770		-	0.2	7.4	-	-
1957	3	11	0.750	-	-	0.2	7.6	-	-
1957	3	12	0.850	-	-	-	-	-	-
1957	3	13	0.800	-	-	-	-	-	-
1957	4	14	0.800	-	-	-	7.7	-	-
1957	4	15	0.860	-	-	-	7.4	-	-
1957	4	16	0.740	-	-	-	7.6	-	-
1957	4	17	0.800	-	-	-	7.7	-	-
1957	5	18	0.790	-	-	-	7.8	-	-
1957	5	19	0.820	-	-	-	7.8	-	-
1957	5	20	0.820	-	-	-	7.8	-	-
1957	5	21	0.870	-	-	-	7.9	-	-
1957	5	22	0.830	-	-	-	7.8	-	-
1957	6	23	0.920	-	-	-	7.8	-	-
1957	6	24	0.880	-	-	-	7.9	-	-
1957	6	25	0.870	-	-	-	7.9	-	-
1957	6	26	0.900	-	-	-	7.9	-	-
1957	7	27	0.900	-	-	-	7.9	-	-
1957	7	28	0.810	-	-	-	7.9	-	-
1957	7	29	0.790	-	-	-	7.9	-	-
1957	7	30	0.830	-	-	-	8.0	-	-
1957	8	31	0.870	-	-	-	7.9	-	-
1957	8	32	0.890	-	-	-	8.1	-	-
1957	8	33	0.850	-	-	-	8.0	-	-
1957	8	34	0.830	-	-	-	8.0	-	-
1957	8	35	0.870	-	-	-	8.0	-	-
1957	9	36	0.780	-	-	-	8.1	-	-
1957	9	37	0.860	-	-	-	8.2	-	-
1957	9	38	0.780	-	-	-	8.2	-	-
1957	9	39	0.860	-	-	-	8.2	-	-
1957	10	40	0.890	-	-	-	8.2	-	-
1957	10	41	0.860	-	-	-	8.1	-	-
1957	10	42	0.840	-	-	-	8.1	-	-
1957	10	43	0.830	-	-	-	8.2	-	-
1957	11	44	01850	-	-	-	8.1	-	-
1957	11	45	0.830		-	-	8.1	-	-
1957	11	46	0.810	-	-	-	8.0	-	-
1957	11	47	1.000	-	-	-	8.0	-	-
1957	11	48	0.830	-	-	-	8.0	-	-
1957	12	49	0.840	-	-	-	8.1	-	-
1957	12	50	0.760	-	-	-	8.1	-	-
1957	12	51	1.000	-	-	-	8.1	-	-
1957	12	52	1.200	-	-	-	8.1	-	-
1958	1	1	0.890	-	-	0.2	8.1	-	-
1958	1	2	0.980	-		0.2	8.1	-	-

- No data.

(continued)

TABLE B-1. (CONTINUED)

Year	Month	Week	Daily Flow MGD	BOD_5 mg/l	Suspended Solids mg/l	Settled Solids mg/l	pH	DO mg/l	BOD_5 Solids mg/l
1958	1	3	0.980	-	-	0.3	8.1	-	-
1958	1	4	0.980	-	-	0.3	8.1	-	-
1958	2	5	1.000	-	-	-	8.1	-	-
1958	2	6	0.960	-	-	0.3	8.0	-	-
1958	2	7	0.920	-	-	0.3	7.9	-	-
1958	2	8	0.900	-	-	0.3	8.0	-	-
1958	3	9	1.020	-	-	0.3	7.9	-	-
1958	3	10	0.990	-	-	0.3	7.9	-	-
1958	3	11	0.950	-	-	0.4	7.9	-	-
1958	3	12	0.980	-	-	0.4	7.9	-	-
1958	3	13	0.940	-	-	0.3	8.0	-	-
1958	4	14	0.980	-	-	0.3	8.0	-	-
1958	4	15	0.930	-	-	0.3	8.0	-	-
1958	4	16	0.890	-	-	0.2	8.0	-	-
1958	4	17	0.900	-	-	0.2	8.0	-	-
1958	5	18	0.890	-	-	0.3	8.0	-	-
1958	5	19	0.970	-	-	0.3	8.0	-	-
1958	5	20	0.900	-	-	0.3	8.0	-	-
1958	5	21	0.910	-	-	0.2	8.0	-	-
1958	5	22	0.920	-	-	0.2	8.0	-	-
1958	6	23	0.930	-	-	0.2	8.0	-	-
1958	6	24	0.920	-	-	0.1	8.1	-	-
1958	6	25	0.940	-	-	-	8.0	-	-
1958	6	26	0.970	-	-	-	8.0	-	-
1958	7	27	0.960	-	-	-	8.0	-	-
1958	7	28	0.940	-	-	-	8.0	-	-
1958	7	29	0.950	-	-	-	7.9	-	-
1958	7	30	0.940	-	-	-	8.0	-	-
1958	8	31	0.960	-	-	-	7.9	-	-
1958	8	32	0.960	-	-	-	8.0	-	-
1958	8	33	1.010	-	-	-	8.0	-	-
1958	8	34	1.020	-	-	-	8.0	-	-
1958	8	35	1.000	-	-	-	8.0	-	-
1958	9	36	1.030	-	-	-	8.0	-	-
1958	9	37	1.030	-	-	0.1	8.1	-	-
1958	9	38	1.020	-	-	-	8.1	-	-
1958	9	39	1.010	-	-	0.1	8.1	-	-
1958	10	40	0.980	-	-	0.1	8.1	-	-
1958	10	41	1.000	-	-	0.1	8.1	-	-
1958	10	42	1.000	-	-	0.1	8.1	-	-
1958	10	43	0.980	-	-	0.1	8.1	-	-
1958	11	44	1.010	-	-	-	8.1	-	-
1958	11	45	1.020	-	-	-	8.1	-	-
1958	11	46	1.040	-	-	-	8.1	-	-
1958	11	47	1.070	-	-	-	8.1	-	-
1958	11	48	1.080	-	-	-	8.1	-	-
1958	12	49	1.050	-	-	0.1	8.1	-	-
1958	12	50	1.030	-	-	0.2	8.2	-	-
1958	12	51	1.050	-	-	0.2	8.2	-	-
1958	12	52	1.010	-	-	0.1	8.2	-	-

- No data.

(continued)

TABLE B-1. (CONTINUED)

Year	Month	Week	Daily Flow MGD	BOD_5 mg/1	Suspended Solids mg/1	Settled Solids mg/1	pH	DO mg/1	BOD_5 Solids mg/1
1959	1	1	1.110	-	2	-	8.1	-	-
1959	1	2	1.120	-	2	-	8.2	-	-
1959	1	3	1.100	-	2	-	8.2	-	-
1959	1	4	1.100	-	2	-	8.1	-	-
1959	2	5	1.090	-	1	-	8.1	-	-
1959	2	6	1.100	-	2	-	8.1	-	-
1959	2	7	1.110	-	1	-	8.2	-	-
1959	2	8	1.060	-	2	-	8.2	-	-
1959	3	9	1.010	-	2	-	8.1	-	-
1959	3	10	1.030	-	2	-	8.2	-	-
1959	3	11	1.000	-	2	-	8.1	-	-
1959	3	12	1.000	-	2	-	8.1	-	-
1959	3	13	1.000	-	2	-	8.1	-	-
1959	4	14	1.040	-	2	-	8.1	-	-
1959	4	15	1.000	-	1	-	8.2	-	-
1959	4	16	0.940	-	3	-	8.2	-	-
1959	4	17	0.910	-	3	-	8.2	-	-
1959	5	18	0.870	-	2	-	8.2	-	-
1959	5	19	0.830	-	2	-	8.2	-	-
1959	5	20	0.890	-	2	-	8.2	-	-
1959	5	21	0.880	-	2	-	8.2	-	-
1959	5	22	0.880	-	2	-	8.1	-	-
1959	6	23	0.860	-	1	-	8.2	-	-
1959	6	24	0.900	-	1	-	8.1	-	-
1959	6	25	8.400	-	-	0.1	8.2	-	-
1959	6	26	9.400	-	-	-	8.2	-	-
1959	7	27	8.600	-	-	0.1	8.2	-	-
1959	7	28	8.900	-	-	-	8.2	-	-
1959	7	29	9.600	-	-	0.1	8.1	-	-
1959	7	30	8.900	-	-	-	8.2	-	-
1959	8	31	9.800	-	-	-	8.2	-	-
1959	8	32	8.600	-	-	0.1	8.2	-	-
1959	8	33	9.300	-	-	0.1	8.2	-	-
1959	8	34	8.900	-	-	0.1	8.1	-	-
1959	8	35	9.700	-	-	0.1	8.2	-	-
1959	9	36	9.100	-	-	0.1	8.2	-	-
1959	9	37	9.500	-	-	0.1	8.1	-	-
1959	9	38	9.800	-	-	0.1	8.1	-	-
1959	9	39	9.500	-	-	0.1	8.2	-	-
1959	11	44	1.030	-	-	0.2	8.1	-	-
1959	11	45	1.030	-	-	0.2	8.2	-	-
1959	11	46	1.010	-	-	0.1	8.2	-	-
1959	11	47	1.050	-	-	0.1	8.1	-	-
1959	11	48	1.070	-	-	0.2	8.2	-	-
1959	12	49	1.050	-	-	0.2	8.2	-	-
1959	12	50	1.060	-	-	0.2	8.2	-	-
1959	12	51	1.070	-	-	0.2	8.2	-	-
1959	12	52	1.070	-	-	0.2	8.2	-	-
1960	1	1	1.050	-	-	0.2	8.2	-	-
1960	1	2	1.100	-	-	0.3	8.3	-	-

- No data.

(continued)

TABLE B-1. (CONTINUED)

Year	Month	Week	Daily Flow MGD	BOD_5 mg/l	Suspended Solids mg/l	Settled Solids mg/l	pH	DO mg/l	BOD_5 Solids mg/l
1960	1	3	1.090	-	-	0.2	8.3	-	-
1960	1	4	1.120	-	-	0.3	8.3	-	-
1960	2	5	1.110	-	-	0.2	8.3	-	-
1960	2	6	1.120	-	-	0.3	8.2	-	-
1960	2	7	1.130	-	-	0.3	8.2	-	-
1960	2	8	1.110	-	-	0.4	8.3	-	-
1960	4	14	1.080	-	-	0.3	8.2	-	-
1960	4	15	0.980	-	-	0.3	8.3	-	-
1960	4	16	1.030	-	-	0.4	8.2	-	-
1960	4	17	1.080	-	-	0.3	8.2	-	-
1960	5	18	1.050	-	-	0.2	8.3	-	-
1960	5	19	1.020	-	-	0.3	8.2	-	-
1960	5	20	1.030	-	-	0.2	8.2	-	-
1960	5	21	1.030	-	-	0.2	8.2	-	-
1960	5	22	0.970	-	-	0.2	8.2	-	-
1960	7	27	1.020	-	-	-	8.3	-	-
1960	7	28	1.030	-	-	-	8.3	-	-
1960	7	29	0.990	-	-	-	8.3	-	-
1960	7	30	1.000	-	-	-	8.3	-	-
1960	8	31	1.020	-	-	0.1	8.2	-	-
1960	8	32	0.990	-	-	0.1	8.3	-	-
1960	8	33	1.030	-	-	0.1	8.2	-	-
1960	8	34	1.000	-	-	0.1	8.2	-	-
1960	8	35	1.010	-	-	0.1	8.2	-	-
1960	9	36	1.010	-	-	0.1	8.2	-	-
1960	9	37	1.000	-	-	0.1	8.2	-	-
1960	9	38	1.010	-	-	0.1	8.2	-	-
1960	9	39	0.980	-	-	0.1	8.2	-	-
1960	10	40	1.030	-	-	0.1	8.2	-	-
1960	10	41	1.030	-	-	0.1	8.2	-	-
1960	10	42	1.030	-	-	0.1	8.2	-	-
1960	10	43	1.020	-	-	0.1	8.2	-	-
1960	11	44	1.020	-	-	0.1	8.2	-	-
1960	11	45	1.040	-	-	-	8.2	-	-
1960	11	45	1.040	-	-	0.1	8.2	-	-
1960	11	47	1.030	-	-	0.1	8.2	-	-
1960	11	48	1.020	-	-	0.1	8.2	-	-
1961	1	1	1.040	-	-	-	8.2	-	-
1961	1	2	1.040	-	-	0.2	8.2	-	-
1961	1	3	1.010	-	-	0.2	8.2	-	-
1961	1	4	1.040	-	-	0.2	8.2	-	-
1961	4	14	0.970	-	-	0.2	8.2	-	-
1961	4	15	1.040	-	-	0.2	8.2	-	-
1961	4	16	0.990	-	-	0.2	8.2	-	-
1961	4	17	1.030	-	-	0.1	8.2	-	-
1961	5	18	1.000	-	-	-	8.2	-	-
1961	5	19	1.040	-	-	0.1	8.2	-	-
1961	5	20	1.040	-	-	0.1	8.2	-	-
1961	5	21	1.000	-	-	-	8.0	-	-
1961	5	22	1.030	-	-	-	8.0	-	-

- No data.

(continued)

TABLE B-1. (CONTINUED)

Year	Month	Week	Daily Flow MGD	BOD_5 mg/l	Suspended Solids mg/l	Settled Solids mg/l	pH	DO mg/l	BOD_5 Solids mg/l
1961	6	23	1.020	-	-	0.3	8.1	-	-
1961	6	24	1.020	-	-	0.1	8.0	-	-
1961	6	25	1.010	-	-	0.1	8.0	-	-
1961	6	26	1.030	-	-	-	7.9	-	-
1961	7	27	1.030	-	-	0.2	7.8	-	-
1961	7	28	1.050	-	-	-	7.8	-	-
1961	7	29	1.070	-	-	-	7.8	-	-
1961	7	30	1.030	-	-	-	7.5	-	-
1961	8	31	1.010	-	-	-	7.6	-	-
1961	8	32	1.050	-	-	0.1	7.5	-	-
1961	8	33	1.070	-	-	-	7.8	-	-
1961	8	34	1.060	-	-	0.1	7.7	-	-
1961	8	35	1.030	-	-	-	7.7	-	-
1961	9	36	1.090	-	-	-	7.7	-	-
1961	9	37	1.050	-	-	-	7.7	-	-
1961	9	38	1.070	-	-	-	7.2	-	-
1961	9	39	1.070	-	-	0.1	7.5	-	-
1961	10	40	1.140	-	-	-	7.8	-	-
1961	10	41	1.130	-	-	0.2	7.7	-	-
1961	10	42	1.090	-	-	0.1	7.8	-	-
1961	10	43	1.110	-	-	0.1	7.8	-	-
1961	11	44	1.090	-	-	0.1	7.8	-	-
1961	11	45	1.100	-	-	0.1	7.7	-	-
1961	11	46	1.100	-	-	0.2	7.7	-	-
1961	11	47	1.110	-	-	0.1	7.5	-	-
1961	11	48	1.060	-	-	0.1	7.5	-	-
1961	12	49	1.030	-	-	0.1	7.6	-	-
1961	12	50	1.040	-	-	0.1	7.6	-	-
1961	12	51	1.080	-	-	0.1	7.6	-	-
1961	12	52	1.070	-	-	0.2	7.5	-	-
1962	1	1	1.060	-	-	0.1	7.5	-	-
1962	1	2	1.070	-	-	0.1	7.6	-	-
1962	1	3	1.020	-	-	0.1	7.6	-	-
1962	1	4	1.070	-	-	0.1	7.5	-	-
1962	2	5	1.070	-	-	0.2	7.7	-	-
1962	2	6	1.050	-	-	0.1	7.6	-	-
1962	2	7	1.040	-	-	0.1	7.6	-	-
1962	2	8	1.030	-	-	0.2	7.7	-	-
1962	3	9	1.120	-	-	0.2	7.6	-	-
1962	3	10	1.080	-	-	0.2	7.6	-	-
1962	3	11	1.060	-	-	0.2	7.7	-	-
1962	3	12	1.060	-	-	0.1	7.5	-	-
1962	3	13	1.100	-	-	0.1	7.5	-	-
1962	4	14	1.070	-	-	0.3	7.6	-	-
1962	4	15	1.030	-	-	0.1	7.6	-	-
1962	4	16	1.030	-	-	0.1	7.5	-	-
1962	4	17	1.030	-	-	0.1	7.5	-	-
1962	5	18	1.060	-	-	0.1	7.6	-	-
1962	5	19	1.060	-	-	0.1	7.5	-	-
1962	5	20	1.090	-	-	0.1	7.6	-	-

- No data.

(continued)

TABLE B-1. (CONTINUED)

Year	Month	Week	Daily Flow MGD	BOD_5 mg/l	Suspended Solids mg/l	Settled Solids mg/l	pH	DO mg/l	BOD_5 Solids mg/l
1962	5	21	1.070	-	-	0.1	7.5	-	-
1962	5	22	1.080	-	-	0.1	7.6	-	-
1962	10	40	1.110	-	-	-	7.6	-	-
1962	10	41	1.120	-	-	-	7.5	-	-
1962	10	42	1.120	-	-	-	8.1	-	-
1962	10	43	1.100	-	-	-	8.5	-	-
1963	2	5	1.230	-	-	-	7.9	-	-
1963	2	6	1.240	-	-	0.1	7.9	-	-
1963	2	7	1.240	-	-	-	7.9	-	-
1963	2	8	1.270	-	-	-	7.9	-	-
1963	3	9	1.260	-	-	-	8.0	-	-
1963	3	10	1.230	-	-	-	8.0	-	-
1963	3	11	1.240	-	-	-	7.9	-	-
1963	3	12	1.220	-	-	0.1	8.0	-	-
1963	3	13	1.220	-	-	0.1	8.0	-	-
1963	4	14	1.200	-	-	-	8.1	-	-
1963	4	15	1.190	-	-	-	8.1	-	-
1963	4	16	1.250	-	-	-	8.4	-	-
1963	4	17	1.210	-	-	-	8.3	-	-
1963	5	18	1.150	-	-	-	8.1	-	-
1963	5	19	1.180	-	-	-	7.9	-	-
1963	5	20	1.200	-	-	-	7.1	-	-
1963	5	21	1.220	-	-	-	7.2	-	-
1963	5	22	1.210	-	-	-	7.9	-	-
1963	6	23	1.230	-	-	-	7.8	-	-
1963	6	24	1.260	-	-	-	7.7	-	-
1963	6	25	1.230	-	-	-	7.7	-	-
1963	6	26	1.240	-	-	-	7.6	-	-
1963	8	31	1.100	-	-	-	7.6	-	-
1963	8	32	1.090	-	-	-	7.6	-	-
1963	8	33	1.070	-	-	-	7.6	-	-
1963	8	34	1.090	-	-	-	7.4	-	-
1963	8	35	1.100	-	-	-	7.5	-	-
1963	10	40	1.290	-	-	-	8.1	-	-
1963	10	41	1.280	-	-	-	7.3	-	-
1963	10	42	1.250	-	-	-	7.2	-	-
1963	10	43	1.250	-	-	0.2	7.4	-	-
1963	11	44	1.280	-	-	0.1	7.1	-	-
1963	11	45	1.280	-	-	0.2	7.3	-	-
1963	11	46	1.290	-	-	0.1	7.3	-	-
1963	11	47	1.270	-	-	-	7.4	-	-
1963	11	48	1.250	-	-	-	7.3	-	-
1963	12	49	1.250	-	-	0.3	7.3	-	-
1963	12	50	1.230	-	-	0.3	7.4	-	-
1963	12	51	1.270	-	-	-	7.5	-	-
1963	12	52	1.220	-	-	-	7.5	-	-
1964	2	5	1.270	-	-	0.1	7.3	-	-
1964	2	6	1.230	-	-	0.2	7.3	-	-
1964	2	7	1.230	-	-	0.1	7.3	-	-
1964	2	8	1.250	-	-	0.2	7.3	-	-

- No data.

(continued)

TABLE B-1. (CONTINUED)

Year	Month	Week	Daily Flow MGD	BOD$_5$ mg/1	Suspended Solids mg/1	Settled Solids mg/1	pH	DO mg/1	BOD$_5$ Solids mg/1
1964	3	9	1.250	-	-	0.2	7.3	-	-
1964	3	10	1.260	-	-	0.2	7.2	-	-
1964	3	11	1.280	-	-	0.2	7.1	-	-
1964	3	12	1.080	-	-	0.1	7.1	-	-
1964	3	13	1.080	-	-	0.1	7.1	-	-
1964	11	44	1.230	-	-	-	7.7	-	-
1964	11	45	1.240	-	-	0.2	7.6	-	-
1964	11	46	1.170	-	-	0.1	7.3	-	-
1964	11	47	1.180	-	-	0.2	7.3	-	-
1964	11	48	1.180	-	-	-	7.3	-	-
1965	3	9	1.230	-	-	-	7.6	-	-
1965	3	10	1.280	-	-	0.1	7.5	-	-
1965	3	11	1.240	-	-	-	7.6	-	-
1965	3	12	1.240	-	-	-	7.5	-	-
1965	3	13	1.280	-	-	-	7.6	-	-
1965	6	23	1.170	-	-	-	7.1	-	-
1965	6	24	1.180	-	-	-	7.6	-	-
1965	6	25	1.180	-	-	0.1	7.8	-	-
1965	6	26	1.240	-	-	-	7.9	-	-
1965	11	44	1.240	-	-	-	7.7	-	-
1965	11	45	1.170	-	-	0.2	7.4	-	-
1965	11	46	1.180	-	-	0.3	7.5	-	-
1965	11	47	1.230	-	-	0.3	7.2	-	-
1965	11	48	1.200	-	-	0.1	7.4	-	-
1966	1	1	1.290	-	-	0.2	7.6	-	-
1966	1	2	1.290	-	-	0.1	7.5	-	-
1966	1	3	1.250	-	-	-	7.4	-	-
1966	1	4	1.240	-	-	0.1	7.5	-	-
1967	7	27	1.350	-	-	0.1	7.2	-	-
1967	7	28	1.330	-	-	0.2	7.0	-	-
1967	7	29	1.410	-	-	0.1	7.2	-	-
1967	7	30	1.410	-	-	0.1	7.0	-	-
1968	-	-	-	-	-	-	-	-	-
1969	4	14	1.111	40	33	0.1	7.5	7.9	-
1969	4	15	1.558	36	24	0.1	7.4	4.0	-
1969	4	16	1.169	35	24	0.1	7.2	7.7	-
1969	4	17	1.123	37	33	0.1	7.5	6.7	-
1969	5	18	1.091	38	30	0.1	7.6	3.2	-
1969	5	20	1.379	35	26	0.1	7.5	4.8	-
1969	5	21	1.352	36	22	0.1	7.6	6.1	-
1969	5	22	1.212	28	19	0.1	7.6	7.2	-
1969	6	23	1.653	35	20	0.1	7.5	3.0	-
1969	6	24	1.455	33	24	0.1	7.6	7.5	-
1969	6	25	1.225	34	20	0.1	7.4	7.0	-
1969	6	26	1.338	38	40	0.1	7.5	2.6	-
1969	7	28	2.486	32	28	0.1	7.5	7.0	-
1969	7	29	1.143	53	1	0.7	6.7	-	-
1969	7	30	1.213	36	25	0.1	7.5	7.0	-
1969	8	31	1.356	35	28	0.1	7.8	7.1	-
1969	8	32	1.599	38	25	0.1	7.5	6.8	-

- No data.

(continued)

TABLE B-1. (CONTINUED)

Year	Month	Week	Daily Flow MGD	BOD_5 mg/l	Suspended Solids mg/l	Settled Solids mg/l	pH	DO mg/l	BOD_5 Solids mg/l
1969	8	33	1.217	33	22	0.1	7.5	7.2	-
1969	8	34	1.257	36	18	0.1	6.3	7.3	-
1969	8	35	1.537	37	25	0.1	7.4	6.3	-
1969	9	36	1.107	38	20	0.1	7.3	7.3	-
1969	9	37	1.216	38	25	0.1	7.5	7.0	-
1969	9	38	1.274	39	19	0.1	7.4	6.9	-
1969	9	39	1.423	35	25	0.1	7.4	7.3	-
1969	10	40	1.440	30	18	0.1	7.5	7.2	-
1969	10	41	1.380	27	21	0.1	7.3	7.0	-
1969	10	42	1.285	36	15	0.1	7.4	6.8	-
1969	10	43	1.251	38	19	0.1	7.5	7.2	-
1969	11	44	1.395	35	19	0.1	7.5	6.9	-
1969	11	45	2.100	33	22	0.1	7.4	7.0	-
1969	11	46	1.245	36	30	0.1	7.5	7.2	-
1969	11	47	2.025	37	26	0.1	7.5	7.0	-
1969	12	48	1.220	40	20	0.1	7.4	7.2	-
1969	12	49	1.128	38	22	0.1	7.5	7.0	-
1969	12	50	1.500	37	20	0.1	7.5	7.2	-
1969	12	51	1.178	35	23	0.1	7.4	7.0	-
1969	12	52	1.240	38	25	0.1	7.4	6.7	-
1970	1	1	1.357	32	20	0.1	7.5	7.0	-
1970	1	2	1.212	33	16	0.1	7.3	6.7	-
1970	1	3	1.216	38	10	0.1	7.4	7.3	-
1970	1	4	1.240	33	12	0.1	7.4	7.5	-
1970	2	5	1.254	35	25	0.1	7.5	7.6	-
1970	2	6	1.300	34	20	0.1	7.5	7.3	-
1970	2	7	1.330	33	22	0.1	7.5	7.2	-
1970	2	8	1.264	26	20	0.1	7.5	7.3	-
1970	2	9	1.327	29	22	0.1	7.4	7.0	-
1971	6	24	1.350	25	10	0.1	7.3	7.2	-
1971	6	25	1.400	23	14	0.1	7.4	7.6	-
1971	6	26	1.250	26	12	0.1	7.2	7.5	-
1971	7	27	1.300	24	10	0.1	7.2	7.8	-
1971	7	28	1.250	28	10	0.1	7.2	7.8	22
1971	7	29	1.368	23	11	0.1	7.5	7.2	19
1971	7	30	1.368	19	8	0.1	7.4	7.6	-
1971	8	31	1.368	20	10	0.1	7.3	7.5	-
1971	8	32	1.200	20	10	0.1	7.3	7.6	-
1971	8	33	1.500	24	10	0.1	7.3	7.5	-
1971	8	34	1.500	21	6	0.1	7.4	7.6	-
1971	8	35	1.500	24	10	0.1	7.5	7.3	-
1971	9	36	1.500	20	8	0.1	7.4	7.9	-
1971	9	37	1.500	22	5	0.1	7.5	7.3	-
1971	9	38	1.500	20	10	0.1	7.3	7.6	-
1971	9	39	1.500	24	4	0.1	7.4	7.8	-
1971	10	40	1.500	22	6	0.1	7.3	7.4	-
1971	10	41	1.500	20	5	0.1	7.4	7.6	-
1971	10	42	1.500	21	7	0.1	7.3	7.1	-
1971	10	43	1.500	19	12	0.1	7.3	7.6	-
1971	11	44	1.500	23	8	0.1	7.4	7.2	-

- No data.

(continued)

TABLE B-1. (CONTINUED)

Year	Month	Week	Daily Flow MGD	BOD_5 mg/l	Suspended Solids mg/l	Settled Solids mg/l	pH	DO mg/l	BOD_5 Solids mg/l
1971	11	45	1.200	22	10	0.1	7.5	7.4	-
1971	11	46	1.500	25	12	0.1	7.3	7.5	-
1971	11	47	1.550	26	10	0.1	7.3	7.6	-
1971	11	48	1.500	25	4	0.1	7.5	7.4	-
1971	12	49	1.600	24	8	0.1	7.4	7.5	-
1971	12	50	1.500	22	5	0.1	7.3	7.4	-
1971	12	51	1.500	20	8	0.1	7.4	7.6	-
1971	12	52	1.650	22	4	0.1	7.4	7.5	-
1972	1	1	1.500	24	60	0.1	7.2	7.3	-
1972	1	2	1.800	21	40	0.1	7.4	7.5	-
1972	1	3	1.600	34	10	0.3	7.4	7.0	-
1972	1	4	1.500	31	18	0.1	7.3	7.2	-
1972	2	5	1.600	30	10	0.2	7.5	7.6	-
1972	2	6	1.800	32	12	0.1	7.4	7.2	-
1972	2	7	1.800	30	15	0.2	7.4	7.0	-
1972	2	8	1.600	27	10	0.1	7.5	7.2	-
1972	2	9	1.450	30	12	0.3	7.3	7.2	-
1972	3	10	1.500	28	10	0.1	7.4	7.5	-
1972	3	11	1.500	26	9	0.1	7.2	7.8	-
1972	3	12	1.202	28	25	0.2	7.5	7.2	-
1972	3	13	1.268	31	22	0.3	7.4	7.0	-
1972	4	14	1.256	18	12	0.1	7.5	7.8	-
1972	4	15	1.227	21	13	0.1	7.3	7.2	-
1972	4	16	1.290	23	16	0.1	7.3	7.4	-
1972	4	17	1.200	27	11	0.2	7.4	7.3	-
1972	5	18	1.921	22	12	0.1	7.4	7.0	-
1972	5	19	1.233	23	12	0.1	7.2	7.3	-
1972	5	20	1.106	30	10	0.1	7.3	7.4	-
1972	5	21	1.053	24	4	0.1	7.3	7.8	-
1972	4	22	1.250	25	16	0.1	7.4	7.3	-
1972	6	23	1.131	26	10	0.1	7.2	7.6	-
1972	6	24	1.065	28	6	0.1	7.4	7.5	-
1972	6	25	1.181	27	16	0.1	7.3	7.4	-
1972	6	26	1.073	22	12	0.1	7.3	7.6	-
1972	7	27	1.127	23	6	0.1	7.5	7.8	15
1972	7	28	1.060	27	18	0.1	7.5	7.2	18
1972	7	29	0.898	24	8	0.1	7.4	7.5	15
1972	7	30	1.200	28	10	0.1	7.5	7.3	12
1972	8	31	1.322	26	13	0.1	7.4	7.3	20
1972	8	32	0.833	28	15	0.1	7.5	7.5	20
1972	8	33	1.155	23	20	0.1	7.2	7.4	19
1972	8	34	1.386	25	10	0.1	7.3	7.5	16
1972	8	35	1.368	22	12	0.1	7.4	7.3	17
1972	9	36	1.368	20	15	0.1	7.5	7.8	18
1972	9	37	1.360	23	10	0.1	7.4	7.6	-
1972	9	38	1.150	20	12	0.1	7.4	7.7	16
1972	9	39	1.169	22	10	0.1	7.5	7.6	10
1972	10	40	1.160	21	4	0.1	7.4	7.3	16
1972	10	41	1.100	27	12	0.1	7.3	7.6	13
1972	10	43	1.200	24	10	0.1	7.3	7.7	15

- No data.

(continued)

TABLE B-1. (CONTINUED)

Year	Month	Week	Daily Flow MGD	BOD$_5$ mg/l	Suspended Solids mg/l	Settled Solids mg/l	pH	DO mg/l	BOD$_5$ Solids mg/l
1972	11	44	1.257	20	15	0.3	7.3	7.5	12
1972	11	45	1.271	24	10	0.1	7.3	7.6	16
1972	11	46	1.300	23	13	0.1	7.4	7.8	15
1972	11	47	1.500	26	10	0.2	7.3	7.6	17
1972	11	48	1.369	30	10	0.1	7.3	7.4	22
1972	12	49	1.154	27	16	0.1	7.4	7.8	16
1972	12	50	1.863	30	21	0.2	7.3	7.1	20
1972	12	51	1.274	33	20	0.2	7.4	7.5	-
1972	12	52	1.122	35	18	0.1	7.5	7.8	26
1973	1	1	1.189	33	12	0.1	7.3	7.2	-
1973	1	2	1.027	31	22	0.1	7.3	7.6	-
1973	1	3	1.225	26	12	0.1	7.4	7.4	-
1973	1	4	1.709	25	10	0.1	7.5	7.3	-
1973	1	5	1.081	24	12	0.1	7.3	7.6	-
1973	2	6	1.053	26	18	0.1	7.4	7.3	-
1973	2	7	1.074	30	14	0.1	7.3	7.6	-
1973	2	8	1.100	26	18	0.1	7.3	7.4	-
1973	2	9	1.080	25	12	0.1	7.4	7.5	-
1973	3	10	0.816	28	8	0.1	7.3	7.6	-
1973	3	11	1.143	31	14	0.1	7.2	7.4	-
1973	3	12	1.317	27	16	0.1	7.4	7.6	-
1973	3	13	1.119	24	15	0.1	7.3	7.4	-
1973	4	14	1.144	23	16	0.1	7.3	7.5	-
1973	4	15	1.097	28	12	0.1	7.3	7.6	-
1973	4	16	1.004	27	13	0.1	7.3	7.4	-
1973	4	17	1.159	25	12	0.1	7.3	7.2	-
1973	5	18	1.108	24	16	0.1	7.4	7.6	-
1973	5	19	1.133	27	18	0.2	7.5	7.3	-
1973	5	20	1.142	26	16	0.2	7.6	7.0	-
1973	5	21	1.606	28	12	0.1	7.5	7.2	-
1973	5	22	1.245	31	13	0.1	7.5	7.2	-
1973	6	23	1.202	26	12	0.1	7.5	7.0	-
1973	6	24	1.284	27	14	0.2	7.4	7.2	-
1973	6	25	1.066	30	8	0.1	7.3	7.1	14
1973	6	26	1.036	26	12	0.1	7.3	7.4	18
1973	7	27	1.144	30	17	0.1	7.3	7.2	19
1973	7	28	1.061	31	10	0.1	7.5	7.2	-
1973	7	29	1.187	30	15	0.1	7.4	7.5	18
1973	7	30	1.101	27	10	0.1	7.3	7.8	15
1973	7	31	0.983	28	12	0.1	7.3	7.4	15
1973	8	32	1.676	30	20	0.2	7.3	7.5	16
1973	8	33	1.707	33	14	0.1	7.3	7.2	10
1973	8	34	1.668	31	10	0.1	7.3	7.1	15
1973	8	35	1.721	30	8	0.1	7.3	7.4	14
1973	9	36	1.679	27	6	0.1	7.3	7.6	-
1973	9	37	2.600	25	10	0.1	7.2	7.4	18
1973	9	38	1.675	26	18	0.3	7.3	7.2	20
1973	9	39	1.857	24	13	0.1	7.2	7.4	16
1973	10	40	1.661	22	15	0.1	7.3	7.5	12
1973	10	41	1.600	23	10	0.1	7.3	7.8	10

- No data.

(continued)

TABLE B-1. (CONTINUED)

Year	Month	Week	Daily Flow MGD	BOD$_5$ mg/1	Suspended Solids mg/1	Settled Solids mg/1	pH	DO mg/1	BOD$_5$ Solids mg/1
1973	10	42	1.375	25	14	0.1	7.3	7.6	16
1973	10	43	1.500	24	12	0.2	7.3	7.4	14
1973	10	44	1.689	22	10	0.1	7.3	7.6	16
1973	11	45	1.652	24	13	0.1	7.3	7.5	18
1973	11	46	1.623	26	12	0.1	7.3	7.4	15
1973	11	47	1.768	27	10	0.1	7.3	7.8	13
1973	12	48	1.710	26	12	0.1	7.3	7.6	12
1973	12	49	1.668	25	15	0.1	7.4	7.5	10
1973	12	50	1.716	27	13	0.1	7.3	7.8	15
1973	12	51	1.600	28	6	0.4	7.4	7.5	15
1973	12	52	1.577	28	15	0.1	7.5	7.7	13
1974	1	1	1.347	32	18	0.1	7.5	7.3	20
1974	1	2	0.975	31	15	0.1	7.5	7.5	18
1974	1	3	2.198	33	15	0.1	7.5	7.7	22
1974	1	4	1.500	25	18	0.1	7.5	7.8	20
1974	1	5	1.500	24	12	0.1	7.3	7.6	16
1974	2	6	1.500	23	15	0.1	7.5	8.1	15
1974	2	7	1.500	24	18	0.2	7.5	7.6	16
1974	2	8	1.500	26	16	0.2	7.5	7.4	19
1974	2	9	1.500	28	19	0.3	7.6	7.9	16
1974	3	10	1.679	26	18	0.1	7.6	7.8	14
1974	3	11	1.692	28	19	0.1	7.5	7.0	16
1974	3	12	1.619	31	20	0.1	7.6	8.1	21
1974	3	13	1.613	33	23	0.2	7.5	7.9	18
1974	4	14	1.600	29	16	0.2	7.8	8.5	21
1974	4	15	1.632	27	15	0.1	7.5	7.8	18
1974	4	16	1.600	30	20	0.1	7.5	7.8	22
1974	4	17	1.433	26	19	0.1	7.3	7.6	18
1974	4	18	1.565	30	21	0.5	7.3	7.8	24
1974	5	19	1.474	31	19	0.2	7.2	-	21
1974	5	20	1.530	26	16	0.1	7.4	7.4	18
1974	5	21	1.490	28	18	0.1	7.4	7.9	19
1974	5	22	1.635	30	18	0.2	7.6	7.4	22
1974	5	23	1.641	32	21	0.1	7.4	7.0	19
1974	6	24	1.500	30	18	0.1	7.3	7.2	17
1974	6	25	1.611	28	20	0.1	7.7	7.2	13
1974	6	26	1.500	24	22	0.2	7.6	7.9	15
1974	7	27	1.665	26	19	0.1	7.5	7.3	13
1974	7	28	1.675	26	21	0.1	7.5	7.1	14
1974	7	29	1.633	26	18	0.2	7.3	7.3	12
1974	7	30	1.484	25	16	0.1	7.3	7.5	13
1974	7	31	1.540	26	18	0.1	7.5	7.5	11
1974	8	32	-	-	-	-	-	-	-
1974	8	33	1.536	2[illegible]	21	0.2	7.5	7.3	13
1974	8	34	1.617	26	19	0.2	7.5	7.4	15
1974	8	35	1.661	24	15	0.3	7.5	7.6	18
1974	9	36	1.818	25	18	0.1	7.4	7.5	20
1974	9	37	1.503	26	17	0.1	7.4	7.1	18
1974	9	38	1.571	25	15	0.1	7.4	7.1	19
1974	9	39	1.605	23	18	0.1	7.5	7.6	15

- No data.

(continued)

TABLE B-1. (CONTINUED)

Year	Month	Week	Daily Flow MGD	BOD$_5$ mg/1	Suspended Solids mg/1	Settled Solids mg/1	pH	DO mg/1	BOD$_5$ Solids mg/1
1974	10	40	2.320	24	19	0.1	7.5	7.2	16
1974	10	41	2.373	23	19	0.1	7.4	7.2	15
1974	10	42	1.569	26	21	0.2	7.3	7.4	18
1974	10	43	-	24	17	0.3	7.5	7.9	15
1974	10	44	1.550	25	19	0.2	7.5	7.8	18
1974	11	45	1.566	28	21	0.2	7.4	7.5	20
1974	11	46	1.547	27	22	0.2	7.3	7.1	18
1974	11	47	1.506	26	21	0.1	7.4	7.9	20
1974	11	48	1.974	28	23	0.1	7.5	7.3	23
1974	12	49	1.541	32	24	0.2	7.5	7.0	25
1974	12	50	1.153	30	21	0.1	7.4	7.2	24
1974	12	51	1.555	31	19	0.1	7.5	8.3	26
1974	12	52	1.500	32	21	0.1	7.5	8.9	28
1975	1	1	1.547	27	20	0.1	7.5	8.5	21
1975	1	2	1.606	29	18	0.2	7.5	8.2	20
1975	1	3	1.940	27	19	0.2	7.4	9.0	18
1975	1	4	2.250	28	16	0.1	7.3	8.8	16
1975	2	5	1.651	28	20	0.1	7.5	8.4	19
1975	2	6	1.663	27	18	0.1	7.3	8.0	15
1975	2	7	1.679	28	21	0.2	7.3	8.4	19
1975	2	8	1.582	26	18	0.1	7.2	8.5	16
1975	3	9	1.587	27	19	0.1	7.5	8.8	19
1975	3	10	1.670	26	20	0.1	7.4	8.3	20
1975	3	11	1.500	25	20	0.2	7.4	8.5	22
1975	3	12	1.500	28	24	0.2	7.4	7.3	25
1975	3	13	1.500	30	27	0.2	7.3	7.5	27
1975	4	14	1.500	31	26	0.1	7.3	8.2	25
1975	4	15	1.500	33	27	0.3	7.4	8.4	28
1975	4	16	1.655	31	23	0.1	7.5	8.0	25
1975	4	17	1.514	28	21	0.1	7.1	8.3	20
1975	5	18	1.524	27	18	0.1	7.5	8.5	18
1975	5	19	1.500	26	21	0.2	7.4	7.9	21
1975	5	20	1.495	28	22	0.1	7.5	9.0	23
1975	5	21	1.409	29	24	0.1	7.4	7.8	25
1975	5	22	1.330	26	19	0.1	7.6	7.9	20
1975	6	23	1.465	24	17	0.1	7.7	8.2	18
1975	6	24	1.458	23	21	0.1	7.6	8.3	16
1975	6	25	1.458	23	21	0.1	7.6	8.3	16
1975	6	26	1.172	22	20	0.1	7.5	8.5	14
1975	6	27	1.091	24	20	0.1	7.6	8.9	13
1975	7	28	1.486	25	22	0.1	7.5	8.1	16
1975	7	29	1.485	22	16	0.1	7.6	8.3	15
1975	7	30	1.906	23	20	0.1	7.5	8.0	18
1975	7	31	1.299	20	23	0.1	7.4	8.2	16
1975	8	32	1.441	22	21	0.1	7.6	8.0	18
1975	8	33	1.600	23	21	0.1	7.6	8.2	15
1975	8	34	1.486	25	23	0.1	7.5	8.7	16
1975	8	35	0.971	22	25	0.1	7.4	8.5	19
1975	9	36	1.500	20	19	0.1	7.5	7.9	18
1975	9	37	1.511	21	18	0.1	7.6	7.8	15

- No data.

(continued)

TABLE B-1. (CONTINUED)

Year	Month	Week	Daily Flow MGD	BOD_5 mg/l	Suspended Solids mg/l	Settled Solids mg/l	pH	DO mg/l	BOD_5 Solids mg/l
1975	9	38	1.552	20	21	0.1	7.5	8.0	16
1975	9	39	1.699	25	23	0.1	7.7	8.0	18
1975	10	40	1.522	23	19	0.1	7.6	7.9	16
1975	10	41	1.592	20	18	0.1	7.6	7.3	15
1975	10	42	1.552	28	22	0.1	7.6	8.8	-
1975	10	43	1.621	26	20	0.1	7.6	8.6	18
1975	11	44	1.450	20	19	0.1	7.6	8.2	16
1975	11	45	1.487	24	20	0.1	7.7	8.0	-
1975	11	46	1.715	26	21	0.1	7.8	8.0	19
1975	11	47	1.505	28	24	0.1	7.5	8.1	-
1975	11	48	-	-	-	-	-	-	-

- No data.

TABLE B-2. ALKALINITY CONCENTRATIONS DETERMINED DURING 1976

PARAMETER: ALKALINITY

UNITS: MG/L AS CACO3

DATE	STATION NUMBER 1	2	3	4	5	6	7	8	9	
JUNE 23, 1976	********	*******	*******	********	257.0	290.0	*******	********	205.0	******
JULY 1, 1976	217.0	259.0	255.0	261.0	262.0	284.0	*******	257.1	104.0	******
JULY 7, 1976	227.0	247.0	246.0	244.0	*******	*******	*******	********	******	******
JULY 8, 1976	********	*******	*******	********	260.0	269.0	*******	********	205.0	******
JULY 13, 1976	223.0	259.0	254.0	270.0	*******	*******	*******	********	******	******
JULY 14, 1976	********	*******	*******	255.0	*******	*******	253.0	261.0	******	******
JULY 15, 1976	********	*******	*******	********	237.0	309.0	*******	241.0	201.0	******
JULY 22, 1976	225.0	234.0	232.0	231.0	237.0	309.0	224.0	226.0	210.0	******
JULY 29, 1976	251.0	262.0	260.0	255.0	270.0	282.0	264.0	257.0	227.0	******
AUG. 5, 1976	219.0	229.0	204.0	214.0	250.0	258.0	*******	230.0	199.0	******
AUG. 12, 1976	234.0	264.0	253.0	256.0	253.0	305.0	*******	263.0	199.0	******
AUG. 20, 1976	254.0	269.0	281.0	276.0	269.0	286.0	*******	266.0	215.0	******
AUG. 27, 1976	260.0	286.0	269.0	277.0	*******	*******	*******	274.0	223.0	******
SEP. 2, 1976	240.0	264.0	*******	264.0	263.0	284.0	*******	261.0	207.0	******
SEP. 10, 1976	273.0	271.0	268.0	263.0	*******	*******	*******	258.0	213.0	******
SEP. 17, 1976	337.0	289.0	289.0	282.0	*******	*******	*******	281.0	220.0	******
SEP. 24, 1976	241.0	261.0	253.0	264.0	*******	*******	*******	253.0	188.0	******
OCT. 1, 1976	254.0	270.0	260.0	********	*******	*******	*******	********	******	******
OCT. 8, 1976	264.0	249.0	206.0	249.0	*******	*******	*******	********	******	******
OCT. 15, 1976	243.0	232.0	231.0	237.0	*******	*******	*******	********	******	******
OCT. 22, 1976	287.0	271.0	256.0	259.0	*******	*******	*******	********	******	******
MAXIMUM	337.0	289.0	289.0	282.0	270.0	309.0	264.0	281.0	227.0	*********
MINIMUM	217.0	229.0	204.0	214.0	237.0	258.0	224.0	226.0	104.0	*********
MEAN	249.9	259.8	251.1	256.3	255.8	287.6	247.0	256.0	201.1	*********
VARIANCE	888.43382	293.06618	546.46250	304.22059	137.06667	278.40889	427.00000	247.00000	891.97802	*********
STD. DEV.	29.80661	17.11918	23.37654	17.44192	11.70755	16.68799	20.66398	15.71623	29.86600	*********

****** = NO DA

TABLE B-3. ALKALINITY CONCENTRATIONS DETERMINED DURING 1977

PARAMETER: ALKALINITY

UNITS: MG/L AS CACO3

DATE	STATION NUMBER 1	2	3	4	5	6	7	8	9	10
MAY 28, 1977	212.7	230.9	*******	310.2	233.2	********	********	233.2	******	******
JUNE 7, 1977	234.5	262.6	262.6	267.5	255.8	********	********	255.8	******	******
JULY 5, 1977	230.1	230.2	233.7	234.5	232.3	********	********	232.3	188.9	******
AUG. 2, 1977	226.7	236.9	231.0	243.0	239.3	********	********	239.3	196.3	******
AUG. 30, 1977	256.6	263.4	257.8	260.6	258.3	********	********	258.3	208.0	******
SEP. 13, 1977	248.2	259.2	252.8	277.6	262.2	********	277.4	262.2	******	******
SEP. 27, 1977	232.5	245.3	231.3	228.6	246.3	********	********	246.3	******	******
SEP. 28, 1977	*********	*******	*******	235.3	*******	********	233.0	*********	******	******
MAXIMUM	256.6	263.4	262.6	310.2	262.2	**********	277.4	262.2	208.0	**********
MINIMUM	212.7	230.2	231.0	228.6	232.3	**********	233.0	232.3	188.9	**********
MEAN	234.5	246.9	244.9	257.2	246.8	**********	255.2	246.8	197.7	**********
VARIANCE	205.92238	217.91238	209.14267	765.32839	150.35238	**********	985.68000	150.35238	92.74333	**********
STD. DEV.	14.35000	14.76186	14.46177	27.66457	12.26183	**********	31.39554	12.26183	9.63033	**********

****** = NO DATA

TABLE B-4. CALCIUM CONCENTRATIONS DETERMINED DURING 1976

PARAMETER: CALCIUM

UNITS: MG/L AS CACO3

DATE	STATION NUMBER									
	1	2	3	4	5	6	7	8	9	10
MAY 19, 1976	********	*******	*******	********	212.0	233.0	*******	********	******	******
MAY 22, 1976	********	*******	*******	********	*******	*******	*******	********	165.0	170.0
MAY 29, 1976	********	*******	*******	********	202.0	225.0	*******	********	165.0	170.0
JUNE 23, 1976	********	*******	*******	********	183.0	205.0	*******	********	160.0	******
JULY 1, 1976	207.0	196.0	239.0	176.0	173.0	187.0	*******	202.0	137.0	******
JULY 7, 1976	210.0	222.0	226.0	215.0	*******	*******	*******	********	******	******
JULY 8, 1976	********	*******	*******	********	224.0	225.0	*******	********	174.0	******
JULY 13, 1976	250.0	230.0	239.0	248.0	*******	*******	*******	********	******	******
JULY 14, 1976	********	*******	*******	253.0	*******	*******	253.0	213.0	******	******
JULY 15, 1976	********	*******	*******	********	233.0	252.0	*******	238.0	184.0	******
JULY 22, 1976	231.0	231.0	241.0	198.0	226.0	214.0	205.0	179.0	183.0	******
JULY 29, 1976	245.0	246.0	237.0	262.0	252.0	253.0	269.0	268.0	177.0	******
AUG. 5, 1976	236.0	195.0	240.0	245.0	218.0	217.0	*******	211.0	193.0	******
AUG. 12, 1976	205.0	217.0	222.0	231.0	268.0	192.0	*******	218.0	170.0	******
AUG. 20, 1976	256.0	241.0	238.0	230.0	230.0	249.0	*******	279.0	193.0	******
AUG. 27, 1976	194.0	208.0	241.0	261.0	*******	*******	*******	247.0	184.0	******
SEP. 2, 1976	228.0	233.0	234.0	246.0	242.0	220.0	*******	229.0	209.0	******
SEP. 10, 1976	227.0	226.0	238.0	248.0	*******	*******	*******	241.0	163.0	******
SEP. 17, 1976	233.0	210.0	237.0	220.0	*******	*******	*******	262.0	181.0	******
SEP. 24, 1976	221.0	226.0	225.0	219.0	*******	*******	*******	256.0	180.0	******
OCT. 1, 1976	258.0	243.0	239.0	241.0	*******	*******	*******	********	******	******
OCT. 8, 1976	251.0	278.0	219.0	250.0	*******	*******	*******	********	******	******
OCT. 15, 1976	258.0	251.0	254.0	259.0	*******	*******	*******	********	******	******
OCT. 22, 1976	228.0	247.0	253.0	245.0	*******	*******	*******	********	******	******
MAXIMUM	258.0	278.0	254.0	262.0	268.0	253.0	269.0	279.0	209.0	170.0
MINIMUM	194.0	195.0	219.0	176.0	173.0	187.0	205.0	179.0	137.0	170.0
MEAN	231.6	229.4	236.6	235.9	221.9	222.7	242.3	234.1	176.1	170.0
VARIANCE	391.118	444.632	88.757	528.291	732.629	475.515	1109.333	831.910	274.250	0.000
STD. DEV.	19.777	21.086	9.421	22.985	27.067	21.806	33.307	28.843	16.560	0.000

****** = NO DATA

TABLE B-5. CALCIUM CONCENTRATIONS DETERMINED DURING 1977

PARAMETER: CALCIUM   UNITS: MG/L AS CACO3

DATE	STATION NUMBER 1	2	3	4	5	6	7	8	9	10
MAY 28, 1977	204.4	197.8	********	371.4	229.7	********	********	229.7	******	******
JUNE 7, 1977	491.5	328.7	254.3	292.6	230.9	********	********	230.9	******	******
JULY 5, 1977	259.5	247.8	257.5	262.4	262.4	********	********	262.4	213.8	******
AUG. 2, 1977	228.4	205.5	236.7	262.7	208.1	********	********	208.1	143.1	******
AUG. 30, 1977	123.7	128.9	105.3	142.1	113.2	********	********	113.2	81.6	******
SEP. 13, 1977	198.5	194.3	205.2	190.7	183.0	********	175.3	183.0	******	******
SEP. 27, 1977	216.4	215.4	208.3	214.4	209.8	********	********	209.8	******	******
SEP. 28, 1977	*********	*******	*******	213.9	*******	********	207.8	*********	******	******
MAXIMUM	491.5	328.7	257.5	371.4	262.4	**********	207.8	262.4	213.8	**********
MINIMUM	123.7	128.9	105.3	142.1	113.2	**********	175.3	113.2	81.6	**********
MEAN	246.1	216.9	211.2	243.8	205.3	**********	191.6	205.3	146.2	**********
VARIANCE	13430.416	3700.971	3182.154	4898.176	2253.153	**********	528.125	2253.153	4376.263	**********
STD. DEV.	115.890	60.836	56.411	69.987	47.467	**********	22.981	47.467	66.153	**********

****** = NO DATA

TABLE B-6. CHLORIDE CONCENTRATIONS DETERMINED DURING 1976

PARAMETER: CHLORIDE

UNITS: MG/L

DATE	STATION NUMBER 1	2	3	4	5	6	7	8	9	10
MAY 19, 1976	********	*******	*******	********	126.8	127.4	*******	********	******	******
MAY 22, 1976	********	*******	*******	********	*******	*******	*******	********	16.5	15.4
MAY 29, 1976	********	*******	*******	********	110.9	129.5	*******	********	19.7	22.2
JUNE 23, 1976	********	*******	*******	********	131.5	139.7	*******	********	19.1	******
JULY 1, 1976	115.2	125.9	128.5	126.4	129.0	136.1	*******	126.9	19.8	******
JULY 7, 1976	132.3	132.3	139.9	136.3	*******	*******	*******	********	******	******
JULY 8, 1976	********	*******	*******	********	136.4	162.8	*******	********	21.2	******
JULY 13, 1976	129.2	157.2	133.4	129.6	*******	*******	*******	********	******	******
JULY 14, 1976	********	*******	*******	136.8	*******	*******	136.8	122.0	******	******
JULY 15, 1976	********	*******	*******	********	128.2	137.2	*******	123.9	19.7	******
JULY 22, 1976	137.1	139.6	141.1	152.3	143.2	140.6	144.7	132.0	22.2	******
JULY 29, 1976	171.4	132.7	138.4	138.4	139.8	137.4	135.0	130.3	20.4	******
AUG. 5, 1976	180.7	143.6	146.0	141.1	151.0	148.5	*******	153.5	23.5	******
AUG. 12, 1976	135.0	142.1	138.0	141.1	139.0	141.6	*******	142.1	22.7	******
AUG. 20, 1976	127.5	139.4	138.8	140.4	143.8	140.4	*******	137.9	23.5	******
AUG. 27, 1976	145.1	131.6	130.1	131.6	*******	*******	*******	137.3	23.7	******
SEP. 2, 1976	126.4	128.0	129.7	135.7	130.2	132.4	*******	130.2	23.3	******
OCT. 1, 1976	136.7	132.6	138.3	149.3	*******	*******	*******	********	******	******
OCT. 15, 1976	133.7	137.6	147.0	135.6	*******	*******	*******	********	******	******
MAXIMUM	180.7	157.2	147.0	152.3	151.0	162.8	144.7	153.5	23.7	22.2
MINIMUM	115.2	125.9	128.5	126.4	110.9	127.4	135.0	122.0	16.5	15.4
MEAN	139.2	136.9	137.4	138.0	134.3	139.5	138.8	133.6	21.2	18.8
VARIANCE	352.43538	71.23970	36.17879	51.56269	110.11424	86.22061	26.62333	88.77656	4.84026	23.12000
STD. DEV.	18.77326	8.44036	6.01488	7.18072	10.49353	9.28551	5.15978	9.42213	2.20006	4.80833

****** = NO DATA

TABLE B-7. CHLORIDE CONCENTRATIONS DETERMINED DURING 1977

PARAMETER: CHLORIDE   UNITS: MG/L

DATE	STATION NUMBER 1	2	3	4	5	6	7	8	9	10
MAY 28, 1977	133.0	106.1	*******	177.2	143.8	********	********	143.8	******	******
JUNE 7, 1977	165.9	158.8	154.3	156.3	155.8	********	********	155.8	******	******
JULY 5, 1977	168.1	170.4	165.0	165.0	171.2	********	********	171.2	19.0	******
AUG. 2, 1977	147.6	150.7	155.8	155.3	149.2	********	********	149.2	23.0	******
AUG. 30, 1977	136.1	130.9	130.9	129.4	129.4	********	********	129.4	24.1	******
SEP. 13, 1977	135.2	140.8	143.4	154.6	145.9	********	142.8	145.9	******	******
SEP. 27, 1977	145.2	136.1	135.6	143.2	135.1	********	********	135.1	******	******
SEP. 28, 1977	********	*******	*******	138.1	*******	********	141.2	********	******	******
MAXIMUM	168.1	170.4	165.0	177.2	171.2	**********	142.8	171.2	24.1	**********
MINIMUM	133.0	106.1	130.9	129.4	129.4	**********	141.2	129.4	19.0	**********
MEAN	147.3	142.0	147.5	152.4	147.1	**********	142.0	147.1	22.0	**********
VARIANCE	209.90667	435.45905	171.07200	231.48411	188.88619	**********	1.28000	188.88619	7.20333	**********
STD. DEV.	14.48816	20.86766	13.07945	15.21460	13.74359	**********	1.13137	13.74359	2.68390	**********

****** = NO DATA

TABLE B-8. HARDNESS CONCENTRATIONS DETERMINED DURING 1976

PARAMETER: HARDNESS

UNITS: MG/L AS CACO3

DATE	STATION NUMBER 1	2	3	4	5	6	7	8	9	10
MAY 19, 1976	*********	********	********	*********	255.0	254.0	********	*********	******	******
MAY 22, 1976	*********	********	********	*********	********	********	********	*********	219.0	213.0
MAY 29, 1976	*********	********	********	*********	272.0	319.0	********	*********	181.0	231.0
JUNE 23, 1976	*********	********	********	*********	259.0	264.0	********	*********	228.0	******
JULY 1, 1976	276.0	284.0	295.0	253.0	222.0	281.0	********	258.0	206.0	******
JULY 7, 1976	243.0	250.0	249.0	250.0	********	********	********	*********	******	******
JULY 8, 1976	*********	********	********	*********	259.0	250.0	********	*********	203.0	******
JULY 13, 1976	284.0	265.0	265.0	275.0	********	********	********	*********	******	******
JULY 14, 1976	*********	********	********	253.0	********	********	255.0	257.0	******	******
JULY 15, 1976	*********	********	********	*********	263.0	266.0	********	251.0	210.0	******
JULY 22, 1976	250.0	243.0	247.0	221.0	227.0	226.0	241.0	224.0	220.0	******
JULY 29, 1976	284.0	300.0	269.0	270.0	279.0	279.0	278.0	269.0	236.0	******
AUG. 5, 1976	272.0	270.0	261.0	272.0	293.0	270.0	********	270.0	236.0	******
AUG. 12, 1976	272.0	284.0	272.0	275.0	285.0	270.0	********	280.0	219.0	******
AUG. 20, 1976	282.0	272.0	269.0	279.0	273.0	277.0	********	279.0	247.0	******
AUG. 27, 1976	277.0	279.0	268.0	280.0	********	********	********	277.0	247.0	******
SEP. 2, 1976	258.0	279.0	245.0	276.0	272.0	273.0	********	270.0	238.0	******
SEP. 10, 1976	286.0	271.0	265.0	273.0	********	********	********	271.0	218.0	******
SEP. 17, 1976	267.0	277.0	272.0	283.0	********	********	********	277.0	239.0	******
SEP. 24, 1976	269.0	271.0	277.0	270.0	********	********	********	277.0	236.0	******
OCT. 1, 1976	275.0	272.0	277.0	289.0	********	********	********	*********	******	******
OCT. 8, 1976	270.0	324.0	233.0	275.0	********	********	********	*********	******	******
OCT. 15, 1976	277.0	277.0	277.0	280.0	********	********	********	*********	******	******
OCT. 22, 1976	273.0	287.0	267.0	277.0	********	********	********	*********	******	******
MAXIMUM	286.0	324.0	295.0	289.0	293.0	319.0	278.0	280.0	247.0	231.0
MINIMUM	243.0	243.0	233.0	221.0	222.0	226.0	241.0	224.0	181.0	213.0
MEAN	271.5	276.8	265.2	269.5	263.3	269.1	258.0	266.2	224.4	222.0
VARIANCE	138.3897	321.4412	218.4044	256.3824	452.2045	481.3561	349.0000	243.9744	322.3958	162.0000
STD. DEV.	11.7639	17.9288	14.7785	16.0119	21.2651	21.9398	18.6815	15.6197	17.9554	12.7279

****** = NO DATA

TABLE B-9. HARDNESS CONCENTRATIONS DETERMINED DURING 1977

PARAMETER: HARDNESS

UNITS: MG/L AS CACO3

DATE	STATION NUMBER 1	2	3	4	5	6	7	8	9	10
MAY 28, 1977	276.8	261.8	*******	295.9	288.9	*******	*******	288.9	******	******
JUNE 7, 1977	262.3	288.8	286.8	265.2	340.9	*******	*******	340.9	******	******
JULY 5, 1977	326.7	269.5	322.6	223.7	244.5	*******	*******	244.5	198.8	******
AUG. 2, 1977	300.6	305.0	297.2	330.6	280.6	*******	*******	280.6	230.9	******
AUG. 30, 1977	132.9	123.3	142.1	101.3	109.3	*******	*******	109.3	101.7	******
SEP. 13, 1977	262.1	284.6	256.5	257.0	240.7	*******	269.2	240.7	******	******
SEP. 27, 1977	251.3	256.3	254.8	256.3	258.3	*******	*******	258.3	******	******
SEP. 28, 1977	********	*******	*******	253.3	*******	*******	259.3	********	******	******
MAXIMUM	326.7	305.0	322.6	330.6	340.9	**********	269.2	340.9	230.9	**********
MINIMUM	132.9	123.3	142.1	101.3	109.3	**********	259.3	109.3	101.7	**********
MEAN	259.0	255.6	260.0	247.9	251.9	**********	264.3	251.9	179.8	**********
VARIANCE	3768.6129	3686.5048	3992.1080	4528.9013	5111.6014	**********	49.0050	5111.6014	4976.7100	**********
STD. DEV.	61.3890	60.7166	63.1831	67.2971	71.4955	**********	7.0004	71.4955	70.5450	**********

****** = NO DATA

TABLE B-10. AMMONIA NITROGEN CONCENTRATIONS DETERMINED DURING 1976

PARAMETER: AMMONIA NITROGEN UNITS: MG/L

DATE	STATION NUMBER									
	1	2	3	4	5	6	7	8	9	10
MAY 19, 1976	*********	********	********	*********	5.56	4.00	********	*********	*******	*******
MAY 22, 1976	*********	********	********	*********	*******	*******	********	*********	0.051	0.105
MAY 29, 1976	*********	********	********	*********	7.60	5.62	********	*********	0.043	0.077
JUNE 23, 1976	*********	********	********	*********	6.73	6.73	********	*********	0.046	*******
JULY 1, 1976	1.36	5.37	6.40	8.57	7.80	6.61	********	7.63	0.044	*******
JULY 7, 1976	6.62	5.42	11.16	9.95	*******	*******	********	*********	*******	*******
JULY 8, 1976	*********	********	********	*********	3.66	3.27	********	*********	0.051	*******
JULY 13, 1976	2.78	4.68	1.93	4.29	*******	*******	********	*********	*******	*******
JULY 14, 1976	*********	********	********	2.58	*******	*******	2.45	6.23	*******	*******
JULY 15, 1976	*********	********	********	*********	6.39	5.42	********	5.69	0.158	*******
JULY 22, 1976	1.51	2.81	0.54	1.19	3.21	1.12	0.92	1.61	0.086	*******
JULY 29, 1976	12.47	5.47	2.80	3.91	4.21	3.74	3.89	5.60	0.085	*******
AUG. 5, 1976	6.61	9.52	7.55	10.48	13.06	8.55	********	10.81	0.058	*******
AUG. 12, 1976	4.95	4.80	3.60	3.89	4.57	3.38	********	4.21	0.024	*******
AUG. 20, 1976	2.87	4.59	3.21	3.66	3.76	4.01	********	4.74	0.028	*******
AUG. 27, 1976	5.92	5.94	4.21	4.87	*******	*******	********	6.58	0.009	*******
SEP. 2, 1976	3.84	5.44	2.65	4.75	4.90	4.63	********	5.63	0.020	*******
SEP. 10, 1976	9.55	6.49	6.43	5.08	*******	*******	********	6.37	0.022	*******
SEP. 17, 1976	4.09	7.25	5.83	5.83	*******	*******	********	6.69	0.020	*******
SEP. 24, 1976	4.55	6.07	6.03	7.02	*******	*******	********	6.89	0.037	*******
OCT. 1, 1976	6.71	7.11	6.71	5.15	*******	*******	********	*********	*******	*******
OCT. 8, 1976	13.10	7.42	4.67	7.38	*******	*******	********	*********	*******	*******
OCT. 15, 1976	15.27	6.40	6.88	6.65	*******	*******	********	*********	*******	*******
OCT. 22, 1976	12.65	6.74	5.63	5.78	*******	*******	********	*********	*******	*******
MAXIMUM	15.27	9.52	11.16	10.48	13.06	8.55	3.89	10.81	0.158	0.105
MINIMUM	1.36	2.81	0.54	1.19	3.21	1.12	0.92	1.61	0.009	0.077
MEAN	6.76	5.97	5.05	5.61	5.95	4.76	2.42	6.05	0.046	0.091
VARIANCE	18.747276	2.182706	6.306961	5.852009	7.388845	3.855824	2.205900	4.330053	0.001236	0.000392
STD. DEV.	4.329812	1.477398	2.511366	2.419093	2.717507	1.963625	1.485227	2.081039	0.035153	0.019799

****** = NO DATA

TABLE B-11. AMMONIA NITROGEN CONCENTRATIONS DETERMINED DURING 1977

PARAMETER: AMMONIA NITROGEN UNITS: MG/L

DATE	STATION NUMBER 1	2	3	4	5	6	7	8	9	10
MAY 7, 1977	10.56	11.01	11.45	11.90	10.51	******	*******	10.51	******	******
MAY 14, 1977	3.13	7.65	4.84	7.69	7.00	******	*******	7.00	******	******
MAY 21, 1977	7.36	6.94	10.04	18.47	5.93	******	*******	5.93	******	******
MAY 28, 1977	3.68	3.13	*******	10.61	4.10	******	*******	4.10	******	******
JUNE 7, 1977	1.99	4.02	4.44	6.39	4.27	******	*******	4.27	******	******
JUNE 14, 1977	9.69	9.94	9.15	12.18	12.72	******	*******	12.72	******	******
JUNE 21, 1977	2.37	4.77	3.41	4.04	7.05	******	*******	7.05	0.068	******
JUNE 28, 1977	0.85	0.45	0.11	1.43	0.73	******	*******	0.73	******	******
JULY 5, 1977	1.54	0.27	0.14	0.03	0.38	******	*******	0.38	0.021	******
JULY 12, 1977	2.34	1.52	0.45	0.41	2.15	******	*******	2.15	0.158	******
JULY 19, 1977	6.18	1.08	0.23	0.37	1.96	******	*******	1.96	0.051	******
JULY 26, 1977	1.13	3.07	1.73	1.78	3.15	******	*******	3.15	0.049	******
AUG. 2, 1977	0.85	0.68	0.15	0.57	0.76	******	*******	0.76	0.036	******
AUG. 9, 1977	1.33	1.42	0.19	0.10	1.53	******	*******	1.53	0.030	******
AUG. 16, 1977	0.63	0.34	0.15	0.68	0.18	******	*******	0.18	0.063	******
AUG. 23, 1977	0.53	0.66	0.39	0.50	0.93	******	*******	0.93	0.068	******
AUG. 30, 1977	0.62	1.53	0.62	0.54	1.25	******	*******	1.25	0.045	******
SEP. 6, 1977	0.23	0.09	0.10	0.62	0.13	******	*******	0.13	0.043	******
SEP. 13, 1977	1.17	1.29	0.80	1.15	1.82	******	1.13	1.82	******	******
SEP. 20, 1977	1.00	1.63	0.54	1.17	1.27	******	*******	1.27	******	******
SEP. 27, 1977	1.50	2.01	1.20	0.80	2.18	******	*******	2.18	******	******
SEP. 28, 1977	********	*******	*******	0.19	******	******	0.12	********	******	******
OCT. 5, 1977	5.52	4.44	2.75	1.11	2.04	******	*******	2.04	******	******
MAXIMUM	10.56	11.01	11.45	18.47	12.72	**********	1.13	12.72	0.158	**********
MINIMUM	0.23	0.09	0.10	0.03	0.13	**********	0.12	0.13	0.021	**********
MEAN	2.92	3.09	2.52	3.60	3.27	**********	0.63	3.27	0.057	**********
VARIANCE	9.128849	10.106654	12.553936	26.101413	11.598521	**********	0.510050	11.598521	0.001338	**********
STD. DEV.	3.021399	3.179096	3.543153	5.108956	3.405660	**********	0.714178	3.405660	0.036582	**********

****** = NO DATA

TABLE B-12. NITRITE NITROGEN CONCENTRATIONS DETERMINED DURING 1976

PARAMETER: NITRITE NITROGEN UNITS: MG/L

DATE	STATION NUMBER 1	2	3	4	5	6	7	8	9	10
MAY 19, 1976	*********	********	********	*********	0,879	0.931	********	*********	******	******
MAY 22, 1976	*********	********	********	*********	******	******	********	*********	0,0032	0,0064
MAY 29, 1976	*********	********	********	*********	1,124	1.114	********	*********	0,0034	0,0078
JUNE 23, 1976	*********	********	********	*********	0,875	0.903	********	*********	0,0031	******
JULY 7, 1976	0,832	0,755	2,087	1,174	******	******	********	*********	******	******
JULY 8, 1976	*********	********	********	*********	0,937	0.975	********	*********	0,0032	******
JULY 13, 1976	0,631	0,631	1,414	1,119	******	******	********	*********	******	******
JULY 14, 1976	*********	********	********	1,682	******	******	1,901	0,914	******	******
JULY 15, 1976	*********	********	********	*********	0,935	0.879	********	0,782	0,0023	******
JULY 22, 1976	0,868	1,124	2,189	1,597	1,508	1.627	1,706	1,292	0,0122	******
JULY 29, 1976	0,748	0,939	2,519	1,425	1,447	1.440	1,510	0,748	0,0051	******
AUG. 12, 1976	1,022	1,141	2,073	1,519	1,488	1.550	********	0,961	0,0041	******
AUG. 20, 1976	0,480	0,637	1,249	0,852	0,836	0.877	********	0,538	0,0076	******
AUG. 27, 1976	0,416	0,406	0,945	0,755	******	******	********	0,435	0,0055	******
SEPT. 2, 1976	0,448	0,396	1,371	0,683	0,660	0.855	********	0,425	0,0020	******
SEP. 10, 1976	0,517	0,505	0,760	0,712	******	******	********	0,403	0,0024	******
SEP. 17, 1976	0,398	0,417	0,695	0,668	******	******	********	0,495	0,0059	******
SEP. 24, 1976	0,647	0,480	0,979	0,749	******	******	********	0,434	0,0020	******
OCT. 1, 1976	0,727	0,572	0,835	0,689	******	******	********	*********	******	******
OCT. 8, 1976	0,784	0,692	0,665	0,787	******	******	********	*********	******	******
OCT. 15, 1976	0,538	0,751	0,875	0,852	******	******	********	*********	******	******
OCT. 22, 1976	0,577	0,770	0,823	0,730	******	******	********	*********	******	******
MAXIMUM	1,022	1,141	2,519	1,682	1,508	1.627	1,901	1,292	0,0122	0,0078
MINIMUM	0,398	0,396	0,665	0,668	0,660	0,855	1,510	0,403	0,0020	0,0064
MEAN	0,642	0,681	1,299	1,000	1,069	1,115	1,706	0,675	0,0044	0,0071
VARIANCE	,03396460	,05764792	,38772026	,13276226	,09387521	,09281499	,03822033	,08397176	,00000774	,00000098
STD. DEV.	,18429487	,24009982	,62267187	,36436556	,30639062	,30465552	,19550021	,28977882	,00278193	,00098995

****** = NO DATA

TABLE B-13. NITRITE NITROGEN CONCENTRATIONS DETERMINED DURING 1977

PARAMETER: NITRITE NITROGEN   UNITS: MG/

DATE	STATION NUMBER 1	2	3	4	5	6	7	8	9	10
MAY 7, 1977	1.078	0.926	0.945	0.853	0.945	******	********	0.945	******	******
MAY 14, 1977	0.909	1.270	1.266	1.266	0.532	******	********	0.532	******	******
MAY 21, 1977	0.932	0.900	0.483	1.137	0.985	******	********	0.985	******	******
MAY 28, 1977	0.599	0.873	********	0.524	1.134	******	********	1.134	******	******
JUNE 7, 1977	0.420	1.459	1.146	0.752	1.091	******	********	1.091	******	******
JUNE 14, 1977	1.058	1.359	1.283	1.152	1.265	******	********	1.265	******	******
JUNE 21, 1977	1.360	1.329	1.722	1.462	1.192	******	********	1.192	0.0437	******
JUNE 28, 1977	0.457	0.639	1.172	1.217	0.788	******	********	0.788	******	******
JULY 5, 1977	0.408	0.481	0.671	0.729	0.525	******	********	0.525	0.0000	******
JULY 12, 1977	0.533	0.745	1.370	1.072	0.864	******	********	0.864	0.0134	******
JULY 19, 1977	0.434	0.405	0.897	1.012	0.463	******	********	0.463	0.0182	******
JULY 26, 1977	0.295	0.502	1.001	1.223	0.461	******	********	0.461	0.0124	******
AUG. 2, 1977	0.150	0.333	0.793	0.633	0.350	******	********	0.350	0.0250	******
AUG. 9, 1977	0.862	0.535	0.656	0.654	0.738	******	********	0.738	0.0127	******
AUG. 16, 1977	0.205	0.372	0.339	0.297	0.283	******	********	0.283	0.0057	******
AUG. 23, 1977	0.496	0.468	0.508	0.408	0.394	******	********	0.394	0.0102	******
AUG. 30, 1977	0.691	0.783	0.787	0.659	0.833	******	********	0.833	0.0039	******
SEP. 6, 1977	0.321	0.438	0.286	0.263	0.350	******	********	0.350	0.0123	******
SEP. 13, 1977	0.232	0.387	0.657	0.642	0.702	******	0.973	0.702	******	******
SEP. 20, 1977	0.237	0.855	0.746	0.640	0.872	******	********	0.872	******	******
SEP. 27, 1977	0.570	0.750	0.870	0.860	0.960	******	********	0.960	******	******
SEP. 28, 1977	********	********	********	0.840	******	******	0.880	*********	******	******
OCT. 5, 1977	0.910	1.120	1.200	0.910	1.340	******	********	1.340	******	******
MAXIMUM	1.360	1.459	1.722	1.462	1.340	**********	0.973	1.340	0.0437	**********
MINIMUM	0.150	0.333	0.286	0.263	0.283	**********	0.880	0.283	0.0000	**********
MEAN	0.598	0.770	0.895	0.835	0.776	**********	0.927	0.776	0.0143	**********
VARIANCE	.11069300	.12501560	.13262993	.10248936	.10298514	**********	.00432450	.10298514	.00014085	**********
STD. DEV.	.33270557	.35357544	.36418392	.32013960	.32091297	**********	.06576093	.32091297	.01186784	**********

****** = NO DATA

TABLE B-14. NITRATE NITROGEN CONCENTRATIONS DETERMINED DURING 1976

PARAMETER: NITRATE NITROGEN UNITS: MG/L

DATE	STATION NUMBER 1	2	3	4	5	6	7	8	9	10
MAY 19, 1976	*********	*******	*******	*********	5.85	6.71	*******	*********	******	******
MAY 22, 1976	*********	*******	*******	*********	******	******	*******	*********	0.530	0.812
MAY 29, 1976	*********	*******	*******	*********	7.11	7.72	*******	*********	0.720	1.530
JUNE 23, 1976	*********	*******	*******	*********	4.68	6.02	*******	*********	0.629	******
JULY 7, 1976	10.22	5.44	4.33	5.11	******	******	*******	*********	******	******
JULY 8, 1976	*********	*******	*******	*********	12.79	5.56	*******	*********	0.650	******
JULY 13, 1976	9.73	6.14	5.70	5.50	******	******	*******	*********	******	******
JULY 14, 1976	*********	*******	*******	6.94	******	******	8.56	6.15	******	******
JULY 15, 1976	*********	*******	*******	*********	3.85	8.48	*******	9.60	0.487	******
JULY 22, 1976	8.59	6.39	5.90	4.50	5.21	4.80	4.61	6.33	0.475	******
JULY 29, 1976	7.82	9.99	2.99	3.48	5.81	3.84	5.06	6.23	0.449	******
AUG. 12, 1976	8.20	4.07	6.79	3.60	4.08	4.80	*******	3.59	0.325	******
AUG. 20, 1976	9.07	4.82	5.26	7.01	5.05	3.60	*******	5.07	0.304	******
AUG. 27, 1976	12.69	5.03	7.01	4.73	******	******	*******	3.97	0.458	******
SEP. 2, 1976	7.04	4.03	4.80	3.18	3.44	3.31	*******	4.07	0.484	******
SEP. 10, 1976	7.35	4.03	3.50	3.38	******	******	*******	4.59	0.277	******
SEP. 17, 1976	5.35	3.20	2.82	2.99	******	******	*******	2.97	0.480	******
SEP. 24, 1976	9.72	3.67	5.78	3.39	******	******	*******	6.12	0.656	******
OCT. 1, 1976	8.28	5.68	6.10	6.48	******	******	*******	*********	******	******
OCT. 8, 1976	9.80	8.33	4.65	7.12	******	******	*******	*********	******	******
OCT. 15, 1976	10.23	5.87	6.36	5.99	******	******	*******	*********	******	******
OCT. 22, 1976	10.48	5.71	7.09	4.76	******	******	*******	*********	******	******
MAXIMUM	17.82	9.99	7.09	7.12	12.79	8.48	8.56	9.60	0.720	1.530
MINIMUM	5.35	3.20	2.82	2.99	3.44	3.31	4.61	2.97	0.277	0.812
MEAN	9.64	5.49	5.27	4.89	5.79	5.48	6.08	5.34	0.495	1.171
VARIANCE	8.100274	3.233995	1.942289	2.167686	7.230290	3.076227	4.675833	3.398867	0.018227	0.257762
STD. DEV.	2.846098	1.798331	1.393660	1.472306	2.688920	1.753918	2.162368	1.843602	0.135007	0.507703

****** = NO DATA

TABLE B-15. NITRATE NITROGEN CONCENTRATIONS DETERMINED DURING 1977

PARAMETER: NITRATE NITROGEN   UNITS: MG/L

DATE	STATION NUMBER 1	2	3	4	5	6	7	8	9	10
MAY 7, 1977	11.70	7.15	6.92	5.48	6.46	******	*******	6.46	******	******
MAY 14, 1977	12.93	7.63	8.78	8.81	6.77	******	*******	6.77	******	******
MAY 21, 1977	18.03	13.95	1.22	8.47	15.00	******	*******	15.00	******	******
MAY 28, 1977	18.45	10.04	*******	2.07	11.25	******	*******	11.25	******	******
JUNE 7, 1977	12.24	6.05	5.37	5.83	8.07	******	*******	8.07	******	******
JUNE 14, 1977	15.31	6.71	9.96	15.40	10.49	******	*******	10.49	******	******
JUNE 21, 1977	10.96	5.29	5.35	4.66	5.65	******	*******	5.65	0.470	******
JUNE 28, 1977	5.16	7.52	7.02	4.16	8.08	******	*******	8.08	******	******
JULY 5, 1977	6.31	4.59	4.30	2.91	5.78	******	*******	5.78	0.241	******
JULY 12, 1977	13.98	10.05	9.78	6.77	11.29	******	*******	11.29	0.694	******
JULY 19, 1977	16.60	11.10	11.85	8.06	12.99	******	*******	12.99	0.537	******
JULY 26, 1977	12.59	11.38	9.32	9.40	10.65	******	*******	10.65	0.521	******
AUG. 2, 1977	9.37	7.05	8.02	7.53	7.03	******	*******	7.03	0.380	******
AUG. 9, 1977	7.31	3.80	6.07	3.85	5.04	******	*******	5.04	0.375	******
AUG. 16, 1977	6.82	4.90	5.42	2.96	4.79	******	*******	4.79	0.433	******
AUG. 23, 1977	18.00	10.35	11.69	7.97	11.86	******	*******	11.86	0.715	******
AUG. 30, 1977	5.43	4.40	4.92	3.83	4.76	******	*******	4.76	0.143	******
SEP. 6, 1977	5.55	4.30	2.92	3.57	4.27	******	*******	4.27	0.089	******
SEP. 13, 1977	5.85	4.82	5.58	4.98	6.04	******	4.45	6.04	******	******
SEP. 20, 1977	6.75	7.98	8.74	8.55	8.78	******	*******	8.78	******	******
SEP. 27, 1977	9.63	8.05	8.13	9.54	8.44	******	*******	8.44	******	******
SEP. 28, 1977	********	*******	*******	8.86	******	******	9.62	********	******	******
OCT. 5, 1977	13.59	11.68	11.70	10.79	12.56	******	*******	12.56	******	******
MAXIMUM	18.45	13.95	11.85	15.40	15.00	*********	9.62	15.00	0.715	*********
MINIMUM	5.16	3.80	1.22	2.07	4.27	*********	4.45	4.27	0.089	*********
MEAN	11.02	7.67	7.29	6.71	8.46	*********	7.04	8.46	0.418	*********
VARIANCE	20.215119	8.188066	8.434033	9.977269	9.667566	*********	13.364050	9.667566	0.041057	*********
STD. DEV.	4.496123	2.861480	2.904101	3.158682	3.109271	*********	3.655742	3.109271	0.202626	*********

****** = NO DATA

TABLE B-16. TOTAL KJELDAHL NITROGEN CONCENTRATIONS DETERMINED DURING 1976

PARAMETER: TOTAL KJELDAHL NITROGEN   UNITS: MG/L

DATE	STATION NUMBER 1	2	3	4	5	6	7	8	9	10
MAY 19, 1976	********	*******	*******	********	11.30	20.63	*******	********	******	******
MAY 22, 1976	********	*******	*******	********	******	******	*******	********	2.44	6.93
MAY 29, 1976	********	*******	*******	********	11.69	35.51	*******	********	0.91	7.74
JUNE 23, 1976	********	*******	*******	********	10.12	15.03	*******	********	0.16	******
JULY 1, 1976	7.10	12.67	14.61	11.91	11.49	21.96	*******	9.63	0.08	******
JULY 7, 1976	7.06	8.56	8.39	7.39	******	******	*******	********	******	******
JULY 8, 1976	********	*******	*******	********	7.48	10.80	*******	********	0.04	******
JULY 13, 1976	10.36	11.41	11.22	10.45	******	******	*******	********	******	******
JULY 14, 1976	********	*******	*******	7.77	******	******	5.85	11.12	******	******
JULY 15, 1976	********	*******	*******	********	10.16	12.56	*******	7.77	0.24	******
JULY 22, 1976	9.57	8.86	10.99	4.25	5.14	7.97	5.41	7.09	0.22	******
JULY 29, 1976	18.07	9.04	9.06	.42	7.07	7.33	7.16	8.35	0.26	******
AUG. 5, 1976	7.89	7.66	7.66	7.19	8.60	7.50	*******	7.93	0.20	******
AUG. 12, 1976	10.48	8.82	7.07	7.50	7.37	7.50	*******	8.95	0.21	******
AUG. 20, 1976	6.01	7.44	*******	6.50	6.46	6.42	*******	7.28	0.53	******
AUG. 27, 1976	12.74	10.62	8.06	7.37	******	******	*******	8.87	0.41	******
SEP. 2, 1976	7.72	8.60	7.17	7.38	7.42	7.72	*******	7.30	0.08	******
SEP. 10, 1976	17.04	10.91	9.93	8.91	******	******	*******	6.99	0.72	******
SEP. 17, 1976	7.34	9.99	8.58	8.66	******	******	*******	9.75	0.60	******
SEP. 24, 1976	8.72	8.04	8.77	8.43	******	******	*******	9.74	0.64	******
OCT. 1, 1976	14.02	11.72	9.65	9.78	******	******	*******	********	******	******
OCT. 8, 1976	20.84	10.23	7.20	9.82	******	******	*******	********	******	******
OCT. 15, 1976	19.86	8.18	8.14	8.30	******	******	*******	********	******	******
OCT. 22, 1976	23.90	10.38	10.12	9.33	******	******	*******	********	******	******
MAXIMUM	23.90	12.67	14.61	11.91	11.69	35.51	7.16	11.12	2.44	7.74
MINIMUM	6.01	7.44	7.07	4.25	5.14	6.42	5.41	6.99	0.04	6.93
MEAN	12.28	9.60	9.16	8.24	8.69	13.41	6.14	8.52	0.48	7.34
VARIANCE	31.873894	2.346213	3.787700	2.869654	4.807742	76.495663	0.828700	1.637674	0.338145	0.328050
STD. DEV.	5.645697	1.531735	1.946201	1.694005	2.192656	8.746180	0.910330	1.279717	0.581502	0.572756

****** = NO DATA

TABLE B-17. TOTAL KJELDAHL NITROGEN CONCENTRATIONS DETERMINED DURING 1977

PARAMETER: TOTAL KJELDAHL NITROGEN UNITS: MG/L

DATE	STATION NUMBER									
	1	2	3	4	5	6	7	8	9	10
MAY 7, 1977	14.69	15.35	14.16	14.08	14.57	******	*******	14.57	******	******
MAY 14, 1977	9.53	13.22	12.69	11.00	12.85	******	*******	12.85	******	******
MAY 21, 1977	13.73	9.81	14.99	13.01	8.97	******	*******	8.97	******	******
MAY 28, 1977	8.13	7.74	*******	18.06	7.86	******	*******	7.86	******	******
JUNE 7, 1977	6.66	8.02	7.62	9.71	7.22	******	*******	7.22	******	******
JUNE 14, 1977	9.21	8.04	7.05	8.81	7.38	******	*******	7.38	******	******
JUNE 21, 1977	10.24	8.84	8.33	9.40	8.62	******	*******	8.62	******	******
JUNE 28, 1977	6.34	5.73	4.84	4.47	5.41	******	*******	5.41	7.71	******
JULY 5, 1977	5.94	6.70	5.48	5.72	5.80	******	*******	5.80	******	******
JULY 12, 1977	6.83	6.84	6.25	5.77	6.42	******	*******	6.42	0.00	******
JULY 19, 1977	13.40	6.12	7.32	4.73	6.05	******	*******	6.05	0.12	******
JULY 26, 1977	5.59	6.03	5.07	4.72	6.33	******	*******	6.33	0.18	******
AUG. 2, 1977	3.25	3.83	3.90	3.47	3.30	******	*******	3.30	0.18	******
AUG. 9, 1977	5.31	5.51	5.49	6.00	4.97	******	*******	4.97	0.00	******
AUG. 16, 1977	4.25	4.31	3.94	3.19	3.57	******	*******	3.57	0.50	******
AUG. 23, 1977	5.30	4.79	3.98	2.68	4.67	******	*******	4.67	0.21	******
AUG. 30, 1977	2.48	3.58	3.00	2.18	2.95	******	*******	2.95	1.73	******
SEP. 6, 1977	4.46	4.21	4.00	2.93	3.65	******	*******	3.65	0.00	******
SEP. 13, 1977	4.44	0.52	0.40	4.12	4.48	******	5.52	4.48	0.62	******
SEP. 20, 1977	5.42	5.10	3.36	2.82	3.48	******	*******	3.48	******	******
SEP. 27, 1977	4.86	5.19	3.26	4.68	4.24	******	*******	4.24	******	******
SEP. 28, 1977	*******	*******	*******	3.45	******	******	3.86	*******	******	******
OCT. 5, 1977	8.87	6.91	5.08	4.58	6.11	******	*******	6.11	******	******
MAXIMUM	14.69	15.35	14.99	18.06	14.57	*********	5.52	14.57	7.71	*********
MINIMUM	2.48	0.52	0.40	2.18	2.95	*********	3.86	2.95	0.00	*********
MEAN	7.22	6.65	6.20	6.50	6.31	*********	4.69	6.31	1.02	*********
VARIANCE	11.543578	10.282282	13.871855	17.789806	8.763672	*********	1.377800	8.763672	5.160902	*********
STD. DEV.	3.397584	3.206600	3.724494	4.217796	2.960350	*********	1.173797	2.960350	2.273522	*********

****** = NO DATA

TABLE B-18. TOTAL PHOSPHORUS CONCENTRATIONS DETERMINED DURING 1976

PARAMETER: TOTAL PHOSPHORUS   UNITS: MG/L

DATE	STATION NUMBER 1	2	3	4	5	6	7	8	9	10
MAY 19, 1976	*********	********	********	*********	6.14	12.52	********	*********	******	******
MAY 22, 1976	*********	********	********	*********	******	******	********	*********	0.328	3.502
MAY 29, 1976	*********	********	********	*********	10.15	46.98	********	*********	0.041	0.750
JUNE 23, 1976	*********	********	********	*********	10.66	19.92	********	*********	0.010	******
JULY 1, 1976	10.10	12.36	14.15	10.43	10.61	80.39	********	10.35	0.015	******
JULY 7, 1976	12.40	12.67	13.23	12.30	******	******	********	*********	******	******
JULY 8, 1976	*********	********	********	*********	6.84	9.06	********	*********	0.033	******
JULY 13, 1976	10.63	10.63	10.94	11.34	******	******	********	*********	******	******
JULY 14, 1976	*********	********	********	8.60	******	******	7.67	10.16	******	******
JULY 15, 1976	*********	********	********	*********	******	10.19	********	9.36	0.090	******
JULY 22, 1976	10.81	8.79	9.36	5.83	5.89	5.55	4.60	8.47	0.013	******
JULY 29, 1976	13.45	11.85	14.29	13.45	13.28	6.38	14.03	18.15	0.015	******
AUG. 5, 1976	14.58	8.45	9.46	9.26	10.74	9.53	********	8.52	0.012	******
AUG. 12, 1976	9.69	9.69	9.45	9.45	9.45	11.49	********	9.22	0.019	******
AUG. 20, 1976	9.62	9.27	10.90	9.44	9.53	10.13	********	9.62	0.077	******
AUG. 27, 1976	11.71	9.69	10.08	9.92	******	******	********	10.16	0.022	******
SEP. 2, 1976	9.76	9.92	11.43	9.92	10.79	10.63	********	9.60	0.020	******
SEP. 10, 1976	11.05	9.88	10.74	9.65	******	******	********	9.34	0.018	******
SEP. 17, 1976	9.28	9.28	10.04	9.81	******	******	********	9.28	0.015	******
SEP. 24, 1976	9.88	9.79	9.79	10.29	******	******	********	9.96	0.012	******
OCT. 1, 1976	10.66	9.67	9.42	9.67	******	******	********	*********	******	******
OCT. 8, 1976	9.52	6.40	6.01	7.52	******	******	********	*********	******	******
OCT. 15, 1976	11.08	9.56	9.48	9.64	******	******	********	*********	******	******
OCT. 22, 1976	12.29	9.67	9.35	10.00	******	******	********	*********	******	******
MAXIMUM	14.58	-12.67	14.29	13.45	13.28	80.39	14.03	18.15	0.328	3.502
MINIMUM	9.28	6.40	6.01	5.83	5.89	5.55	4.60	8.47	0.010	0.750
MEAN	10.97	9.86	10.48	9.81	9.46	19.90	8.77	10.17	0.046	2.126
VARIANCE	2.22511	2.16981	4.02952	2.68572	5.18750	484.22406	23.13323	6.08638	0.00620	3.78675
STD. DEV.	1.49168	1.47303	2.00737	1.63882	2.27761	22.00509	4.80970	2.46706	0.07872	1.94596

****** = NO DATA

TABLE B-19. TOTAL PHOSPHORUS CONCENTRATIONS DETERMINED DURING 1977

PARAMETER: TOTAL PHOSPHORUS UNITS: MG/L

DATE	STATION NUMBER									
	1	2	3	4	5	6	7	8	9	10
MAY 7, 1977	11,59	11,59	11,75	10,79	11,35	******	*******	11,35	******	******
MAY 14, 1977	9,96	9,74	9,43	9,06	5,74	******	*******	5,74	******	******
MAY 21, 1977	13,58	11.08	12.92	12,50	11.13	******	*******	11.13	******	******
MAY 28, 1977	10,99	8,26	*******	17,20	10,53	******	*******	10,53	******	******
JUNE 7, 1977	12,13	12,20	11,34	7,80	13,62	******	*******	13,62	******	******
JUNE 14, 1977	13,48	13.13	12,86	13.13	12,42	******	*******	12,42	******	******
JUNE 21, 1977	10,84	13.82	9,47	8,86	9,92	******	*******	9,92	0,143	******
JUNE 28, 1977	9,92	9,04	8.15	8,55	8,64	******	*******	8,64	******	******
JULY 5, 1977	10,69	9,39	8,40	6,11	8,40	******	*******	8,40	******	******
JULY 12, 1977	9,55	8,61	7,83	5,48	7,83	******	*******	7,83	0,012	******
JULY 19, 1977	8,46	8,08	7,69	6,92	8,46	******	*******	8,46	0,020	******
JULY 26, 1977	10,77	10,00	9,92	10,08	10,39	******	*******	10,39	0,039	******
AUG. 2, 1977	10,53	9,80	11.74	9,32	10,28	******	*******	10,28	0,033	******
AUG. 9, 1977	11,44	11.27	11.27	9,45	11,21	******	*******	11.21	0,032	******
AUG. 16, 1977	11,81	11.37	10.39	9,29	10,08	******	*******	10,08	0,032	******
AUG. 23, 1977	12,34	11.03	8,90	6,61	6,28	******	*******	6,28	0,428	******
AUG. 30, 1977	7,52	8,60	8,72	7,86	7,64	******	*******	7,64	0,020	******
SEP. 6, 1977	9,19	10,22	11,26	7,41	8,30	******	*******	8,30	0,030	******
SEP. 13, 1977	8,92	8,12	7,84	7,98	7,79	******	7,41	7,79	******	******
SEP. 20, 1977	11,18	10,55	10,23	10,04	10,10	******	*******	10,10	******	******
SEP. 27, 1977	11,50	10,80	9,83	9,77	10,70	******	*******	10,70	******	******
SEP. 28, 1977	********	*******	*******	9,90	******	******	9,70	********	******	******
OCT. 5, 1977	10,73	10,09	9,77	9,32	10,15	******	*******	10,15	******	******
MAXIMUM	13,58	13,82	12,92	17,20	13,62	**********	9,70	13,62	0,428	*********
MINIMUM	7,52	8,08	7,69	5,48	5,74	**********	7,41	5,74	0,012	*********
MEAN	10,78	10,31	9,99	9,28	9,59	**********	8,56	9,59	0,079	*********
VARIANCE	2,25050	2,47236	2,61143	6,33684	3,69887	**********	2,62205	3,69887	0,01643	*********
STD. DEV.	1,50017	1,57238	1,61599	2,51731	1,92324	**********	1,61927	1,92324	0,12819	*********

****** = NO DATA

TABLE B-20. TOTAL SOLUBLE PHOSPHORUS CONCENTRATIONS DETERMINED DURING 1976

PARAMETER: TOTAL SOLUBLE PHOSPHORUS   UNITS: MG/L

DATE	STATION NUMBER 1	2	3	4	5	6	7	8	9	10
MAY 29, 1976	*********	*******	*******	*********	9,46	8,60	*******	*********	0,010	0,084
JUNE 23, 1976	*********	*******	*******	*********	9,53	9,34	*******	*********	0,010	******
JULY 1, 1976	8,57	9,57	9,34	9,50	9,88	9,73	*******	10,04	0,019	******
JULY 7, 1976	10,55	11,57	11,38	12,21	******	******	*******	*********	******	******
JULY 8, 1976	*********	*******	*******	*********	6,08	5,28	*******	*********	0,055	******
JULY 13, 1976	9,61	9,45	8,98	9,92	******	******	*******	*********	******	******
JULY 14, 1976	*********	*******	*******	7,98	******	******	7,04	10,39	******	******
JULY 15, 1976	*********	*******	*******	*********	10,12	8,75	*******	8,75	0,087	******
JULY 22, 1976	8,71	5,93	6,09	3,22	3,67	3,62	3,53	4,75	0,048	******
JULY 29, 1976	8,99	9,83	9,92	10,34	10,00	9,92	9,92	10,34	0,022	******
AUG. 5, 1976	7,58	7,64	7,91	8,05	8,59	8,11	*******	8,05	0,020	******
AUG. 12, 1976	8,35	8,82	8,90	9,06	8,90	8,59	*******	8,98	0,018	******
AUG. 20, 1976	8,68	9,70	8,93	9,70	10,04	9,62	*******	9,53	0,053	******
AUG. 27, 1976	8,99	9,30	9,07	9,46	******	******	*******	9,22	0,021	******
SEP. 2, 1976	8,97	9,68	8,17	9,13	9,37	9,60	*******	9,13	0,014	******
SEP. 10, 1976	8,88	9,19	9,73	9,26	******	******	*******	9,03	0,011	******
SEP. 17, 1976	8,44	9,73	9,35	8,97	******	******	*******	8,97	0,008	******
SEP. 24, 1976	8,72	9,46	9,30	9,88	******	******	*******	9,55	0,010	******
OCT. 1, 1976	8,76	6,96	9,09	8,76	******	******	*******	*********	******	******
OCT. 8, 1976	7,32	6,61	5,58	7,95	******	******	*******	*********	******	******
OCT. 15, 1976	8,92	10,04	9,16	9,00	******	******	*******	*********	******	******
OCT. 22, 1976	9,59	9,43	9,35	9,10	******	******	*******	*********	******	******
MAXIMUM	10,55	11,57	11,38	12,21	10,12	9,92	9,92	10,39	0,087	0,084
MINIMUM	7,32	5,93	5,58	3,22	3,67	3,62	3,53	4,75	0,008	0,084
MEAN	8,80	8,99	8,84	8,97	8,75	8,29	6,83	8,98	0,027	0,084
VARIANCE	0,534928	2,005676	1,821553	3,015768	3,801669	4,061702	10,241100	2,040174	0,000518	*********
STD. DEV.	0,731388	1,416219	1,349649	1,736597	1,949787	2,015366	3,200172	1,428347	0,022767	*********

****** = NO DATA

TABLE B-21. TOTAL SOLUBLE PHOSPHORUS CONCENTRATIONS DETERMINED DURING 1977.

PARAMETER: TOTAL SOLUBLE PHOSPHORUS UNITS: MG/L

DATE	STATION NUMBER 1	2	3	4	5	6	7	8	9	10
MAY 28, 1977	10.08	7.65	********	14.17	9.62	******	********	9.62	******	******
JUNE 7, 1977	11.73	12.05	12.91	7.64	11.89	******	********	11.89	******	******
JULY 5, 1977	9.77	6.03	6.11	3.05	6.49	******	********	6.49	******	******
AUG. 2, 1977	9.84	8.58	8.91	7.85	9.72	******	********	9.72	******	******
AUG. 30, 1977	7.16	6.93	6.90	6.66	7.05	******	********	7.05	0.030	******
SEP. 13, 1977	7.53	7.77	7.25	7.15	6.82	******	6.66	6.82	******	******
SEP. 27, 1977	9.57	9.90	9.25	8.61	10.28	******	********	10.28	******	******
SEP. 28, 1977	*********	********	********	8.35	******	******	7.87	*********	******	******
MAXIMUM	11.73	12.05	12.91	14.17	11.89	**********	7.87	11.89	0.030	**********
MINIMUM	7.16	6.03	6.11	3.05	6.49	**********	6.66	6.49	0.030	**********
MEAN	9.35	8.42	8.56	7.96	8.84	**********	7.27	8.84	0.030	**********
VARIANCE	2.435762	4.056729	5.999030	9.386057	4.260981	**********	0.732050	4.260981	**********	**********
STD. DEV.	1.560693	2.014132	2.449292	3.063667	2.064214	**********	0.855599	2.064214	**********	**********

****** = NO DATA

TABLE B-22. ORTHO PHOSPHORUS CONCENTRATIONS DETERMINED DURING 1976

PARAMETER: ORTHO PHOSPHORUS UNITS: MG/L

DATE	STATION NUMBER 1	2	3	4	5	6	7	8	9	10
MAY 19, 1976	*********	********	********	*********	10.24	9.08	********	*********	*******	*******
MAY 22, 1976	*********	********	********	*********	*******	*******	********	*********	0.007	0.052
MAY 29, 1976	*********	********	********	*********	9.05	8.53	********	*********	0.010	0.078
JUNE 23, 1976	*********	********	********	*********	9.01	9.24	********	*********	0.009	*******
JULY 1, 1976	7.45	9.09	8.63	9.20	9.43	9.05	********	9.20	0.015	*******
JULY 7, 1976	8.86	10.96	8.54	10.38	*******	*******	********	*********	*******	*******
JULY 8, 1976	*********	********	********	*********	5.92	5.95	********	*********	0.010	*******
JULY 13, 1976	8.54	8.98	8.62	9.29	*******	*******	********	*********	*******	*******
JULY 14, 1976	*********	********	********	7.44	*******	*******	6.82	9.34	*******	*******
JULY 15, 1976	*********	********	********	*********	9.22	9.29	********	10.11	0.048	*******
JULY 22, 1976	7.66	5.78	6.02	3.03	2.46	3.21	3.41	4.38	0.039	*******
JULY 29, 1976	9.08	10.47	9.74	9.74	10.13	10.04	9.74	9.70	0.014	*******
AUG. 5, 1976	6.72	7.70	7.70	8.07	8.14	8.14	********	7.70	0.031	*******
AUG. 12, 1976	7.62	8.73	8.42	8.85	8.65	8.50	********	8.50	0.043	*******
AUG. 20, 1976	8.19	9.55	9.01	9.47	9.79	9.63	********	9.01	0.023	*******
AUG. 27, 1976	8.41	8.91	8.83	9.21	*******	*******	********	8.79	0.017	*******
SEP. 2, 1976	7.65	8.77	7.38	8.85	8.85	8.92	********	8.77	0.012	*******
SEP. 10, 1976	8.43	9.09	9.32	9.17	*******	*******	********	6.59	0.005	*******
SEP. 17, 1976	7.91	9.16	8.78	9.06	*******	*******	********	8.71	0.003	*******
SEP. 24, 1976	8.42	9.46	9.21	9.79	*******	*******	********	9.42	0.005	*******
OCT. 1, 1976	7.75	8.55	8.71	8.15	*******	*******	********	*********	*******	*******
OCT. 8, 1976	8.27	8.43	6.69	8.66	*******	*******	********	*********	*******	*******
OCT. 15, 1976	8.70	9.38	9.22	9.30	*******	*******	********	*********	*******	*******
OCT. 22, 1976	8.62	8.78	8.90	8.78	*******	*******	********	*********	*******	*******
MAXIMUM	9.08	10.96	9.74	10.38	10.24	10.04	9.74	10.11	0.048	0.078
MINIMUM	6.72	5.78	6.02	3.03	2.46	3.21	3.41	4.38	0.003	0.052
MEAN	8.13	8.93	8.45	8.69	8.41	8.30	6.66	8.63	0.018	0.065
VARIANCE	0.362413	1.211574	0.950526	2.455363	4.782220	3.614961	10.037233	1.994186	.00020763	.00033800
STD. DEV.	0.602008	1.100715	0.974949	1.566960	2.186829	1.901305	3.168159	1.412156	.01440934	.01838478

****** = NO DATA

TABLE B-23. ORTHO PHOSPHORUS CONCENTRATIONS DETERMINED DURING 1977

PARAMETER: ORTH PHOSPHORUS   UNITS: MG/L

DATE	STATION NUMBER 1	2	3	4	5	6		8	9	1
MAY 20, 1977	9.77	.50	********	13.79	9.47	*******	********	9.47	******	******
JUNE 7, 1977	10.87	12.01	11.42	7.40	11.93	*******	********	11.93	******	******
JULY 5, 1977	9.16	6.18	5.73	1.15	6.18	*******	********	6.18	0.021	******
AUG. 2, 1977	9.66	8.46	8.79	7.90	9.39	*******	********	9.39	******	******
AUG. 30, 1977	6.21	6.33	5.37	5.49	5.97	*******	********	5.97	0.023	******
SEP. 13, 1977	6.91	7.54	6.82	6.98	7.39	*******	6.33	7.39	******	******
SEP. 27, 1977	9.36	9.44	8.88	8.31	9.60	*******	********	9.60	******	******
SEP. 28, 1977	*********	********	********	7.95	*******	*******	7.67	*********	******	******
MAXIMUM	10.87	12.01	11.42	13.79	11.93	***********	7.67	11.93	0.023	**********
MINIMUM	6.21	6.18	5.37	1.15	5.97	***********	6.33	5.97	0.021	**********
MEAN	8.85	8.21	7.84	7.38	8.56	***********	7.00	8.56	0.022	**********
VARIANCE	2.778714	4.103948	5.278750	12.157612	4.616148	***********	0.897800	4.616148	.00000200	**********
STD. DEV.	1.666948	2.025820	2.297553	3.486777	2.148522	***********	0.947523	2.148522	.00141421	**********

****** = NO DATA

TABLE B-24. TOTAL DISSOLVED SOLIDS CONCENTRATIONS DETERMINED DURING 1976

PARAMETER: TOTAL DISSOLVED SOLIDS UNITS: MG/L

DATE	STATION NUMBER 1	2	3	4	5	6	7	8	9	10
MAY 19, 1976	*********	********	********	*********	692.0	714.0	********	*********	******	******
MAY 22, 1976	*********	********	********	*********	********	********	********	*********	330.0	332.0
MAY 29, 1976	*********	********	********	*********	644.0	646.0	********	*********	334.0	320.0
JUNE 23, 1976	*********	********	********	*********	410.0	328.0	********	*********	46.0	******
JULY 1, 1976	542.0	586.0	464.0	524.0	432.0	470.0	********	1102.0	244.0	******
JULY 7, 1976	798.0	760.0	788.0	704.0	********	********	********	*********	******	******
JULY 8, 1976	*********	********	********	*********	486.0	688.0	********	*********	90.0	******
JULY 13, 1976	874.0	954.0	728.0	690.0	********	********	********	*********	******	******
JULY 14, 1976	*********	********	********	726.0	********	********	774.0	716.0	******	******
JULY 15, 1976	*********	********	********	*********	932.0	808.0	********	*********	202.0	******
JULY 22, 1976	762.0	738.0	634.0	620.0	684.0	668.0	660.0	848.0	532.0	******
AUG. 5, 1976	734.0	740.0	708.0	708.0	704.0	716.0	********	636.0	334.0	******
AUG. 12, 1976	600.0	598.0	564.0	562.0	562.0	548.0	********	616.0	182.0	******
SEP. 2, 1976	580.0	564.0	540.0	592.0	556.0	610.0	********	594.0	238.0	******
SEP. 1, 1976	658.0	672.0	694.0	784.0	********	********	********	*********	******	******
MAXIMUM	874.0	954.0	788.0	784.0	932.0	808.0	774.0	1102.0	532.0	332.0
MINIMUM	542.0	564.0	464.0	524.0	410.0	328.0	660.0	594.0	46.0	320.0
MEAN	693.5	701.5	640.0	656.7	610.2	619.6	717.0	752.0	253.2	326.0
VARIANCE	13667.14	16260.29	11996.57	7387.00	24239.51	19338.49	6498.00	37985.60	19361.96	72.00
STD. DEV.	116.91	127.52	109.53	85.95	155.69	139.06	80.61	194.90	139.15	8.49

****** = NO DATA

TABLE B-25. TOTAL DISSOLVED SOLIDS CONCENTRATIONS DETERMINED DURING 1977

PARAMETER: TOTAL DISSOLVED SOLIDS UNITS: MG/L

DATE	STATION NUMBER									
	1	2	3	4	5	6	7	8	9	10
MAY 14, 1977	806.0	830.0	722.0	716.0	680.0	********	********	680.0	******	******
MAY 28, 1977	587.0	480.0	********	572.0	604.0	********	********	604.0	******	******
JUNE 7, 1977	623.0	560.0	631.0	651.0	669.0	********	********	669.0	******	******
JULY 5, 1977	652.0	562.0	532.0	492.0	496.0	********	********	496.0	23.0	******
AUG. 2, 1977	644.0	648.0	660.0	594.0	639.0	********	********	639.0	272.0	******
AUG. 30, 1977	610.0	632.0	634.0	663.0	659.0	********	********	659.0	1654.0	******
SEP. 27, 1977	532.0	617.0	596.0	597.0	579.0	********	********	579.0	******	******
SEP. 28, 1977	*********	********	********	582.0	********	********	572.0	*********	******	******
MAXIMUM	806.0	830.0	722.0	716.0	680.0	**********	572.0	680.0	1654.0	**********
MINIMUM	532.0	480.0	532.0	492.0	496.0	**********	572.0	496.0	23.0	**********
MEAN	636.3	618.4	629.2	608.4	618.0	**********	572.0	618.0	649.7	**********
VARIANCE	7213.57	11930.62	4027.37	4611.70	4194.67	**********	**********	4194.67	772014.33	**********
STD. DEV.	84.93	109.23	63.46	67.91	64.77	**********	**********	64.77	878.64	**********

****** = NO DATA

TABLE B-26. TOTAL SUSPENDED SOLIDS CONCENTRATIONS DETERMINED DURING 1976

PARAMETER: TOTAL SUSPENDED SOLIDS   UNITS: MG/L

DATE					STATION	NUMBER				
		2	3	4	5	6	7	8	9	10
JUNE 23, 1976	********	*******	*******	********	32.2	3192.7	*******	********	1.5	******
JULY 1, 1976	41.5	48.5	430.0	37.4	74.1	3286.9	*******	11.5	2.0	******
JULY 7, 1976	41.2	22.3	164.6	26.2	*******	*******	*******	********	******	******
JULY 8, 1976	********	*******	*******	********	27.9	484.0	*******	********	1.4	******
JULY 13, 1976	34.7	81.7	289.7	28.6	*******	*******	*******	********	******	******
JULY 14, 1976	********	*******	*******	21.2	*******	*******	33.1	10.8	******	******
JULY 15, 1976	********	*******	*******	********	22.2	1479.1	*******	8.1	3.1	******
JULY 22, 1976	45.2	44.7	114.2	29.2	44.4	164.9	35.8	52.2	1.8	******
JULY 29, 1976	68.2	11.7	322.5	22.4	35.0	148.7	210.2	11.7	1.8	******
AUG. 5, 1976	35.7	20.5	105.6	92.8	313.3	414.4	*******	13.2	1.6	******
AUG. 12, 1976	23.9	25.7	43.6	25.2	43.9	2848.6	*******	22.8	2.7	******
AUG. 20, 1976	14.1	7.2	255.1	58.4	35.3	98.8	*******	7.9	4.0	******
AUG. 27, 1976	74.9	11.9	55.2	14.5	*******	*******	*******	25.0	2.3	******
SEP. 2, 1976	29.9	16.5	786.5	33.2	17.6	422.7	*******	10.2	2.2	******
SEP. 10, 1976	44.6	9.5	48.4	16.1	*******	*******	*******	10.6	3.5	******
SEP. 17, 1976	37.1	8.5	52.8	22.1	*******	*******	*******	15.1	1.9	******
SEP. 24, 1976	30.5	5.1	17.1	19.8	*******	*******	*******	23.3	1.1	******
OCT. 1, 1976	60.0	8.1	21.9	33.8	*******	*******	*******	********	******	******
OCT. 8, 1976	88.3	19.6	48.9	11.8	*******	*******	*******	********	******	******
OCT. 15, 1976	84.9	17.5	19.2	20.3	*******	*******	*******	********	******	******
OCT. 22, 1976	92.3	15.6	29.6	42.4	*******	*******	*******	********	******	******
MAXIMUM	92.3	81.7	786.5	92.8	313.3	3286.9	210.2	52.2	4.0	*********
MINIMUM	14.1	5.1	17.1	11.8	17.6	98.8	33.1	7.9	1.1	*********
MEAN	49.8	22.0	165.0	30.9	64.6	1254.1	93.0	17.1	2.2	*********
VARIANCE	567.9	383.7	41216.9	363.0	7879.6	1801762.3	10297.8	144.8	0.703791	*********
STD. DEV.	23.8	19.6	203.0	19.1	88.8	1342.3	101.5	12.0	0.838923	*********

****** = NO DATA

TABLE B-27. TOTAL SUSPENDED SOLIDS CONCENTRATIONS DETERMINED DURING 1977

PARAMETER: TOTAL SUSPENDED SOLIDS UNITS: MG/L

DATE	STATION NUMBER 1	2	3	4	5	6	7	8	9	10
MAY 7, 1977	38.8	34.3	36.9	18.5	28.2	********	********	28.2	******	******
MAY 14, 1977	31.4	21.7	56.4	22.7	17.5	********	********	17.5	******	******
MAY 21, 1977	59.5	32.2	52.0	293.2	21.7	********	********	21.7	******	******
MAY 28, 1977	42.0	31.1	********	116.9	16.3	********	********	16.3	******	******
JUNE 7, 1977	42.5	29.0	22.3	43.8	14.6	********	********	14.6	******	******
JUNE 14, 1977	44.0	15.9	64.4	31.0	9.2	********	********	9.2	******	******
JUNE 21, 1977	18.0	339.1	22.3	53.4	5.8	********	********	5.8	1.9	******
JUNE 28, 1977	19.7	41.3	130.2	23.1	38.7	********	********	38.7	******	******
JULY 5, 1977	15.9	126.2	164.7	67.8	43.3	********	********	43.3	1.9	******
JULY 12, 1977	34.7	33.3	131.4	103.4	26.9	********	********	26.9	0.7	******
JULY 19, 1977	24.2	5.3	269.1	40.2	17.7	********	********	17.7	0.8	******
JULY 26, 1977	70.0	18.6	55.0	46.1	13.2	********	********	13.2	10.7	******
AUG. 2, 1977	14.8	23.3	61.4	29.4	10.6	********	********	10.6	2.4	******
AUG. 9, 1977	18.6	37.1	62.9	83.1	9.8	********	********	9.8	2.5	******
AUG. 16, 1977	49.1	51.0	192.1	40.2	22.6	********	********	22.6	3.4	******
AUG. 23, 1977	26.2	37.4	35.2	27.8	32.5	********	********	32.5	33.0	******
AUG. 30, 1977	20.5	21.8	80.6	49.3	5.7	********	********	5.7	1.3	******
SEP. 6, 1977	15.5	42.5	42.9	69.5	26.1	********	********	26.1	5.0	******
SEP. 13, 1977	18.5	19.9	57.5	69.7	7.1	********	171.4	7.1	******	******
SEP. 20, 1977	43.6	31.2	74.3	28.0	16.8	********	********	16.8	******	******
SEP. 27, 1977	18.8	34.4	49.2	36.7	6.3	********	********	6.3	******	******
SEP. 28, 1977	*********	********	********	44.8	********	********	83.3	*********	******	******
OCT. 5, 1977	15.6	18.8	43.7	22.5	22.1	********	********	22.1	******	******
MAXIMUM	70.0	339.1	269.1	293.2	43.3	**********	171.4	43.3	33.0	**********
MINIMUM	14.8	5.3	22.3	18.5	5.7	**********	83.3	5.7	0.7	**********
MEAN	31.0	47.5	81.2	59.2	18.8	**********	127.4	18.8	5.8	**********
VARIANCE	248.5	4775.3	3909.3	3279.9	112.4	**********	3880.8	112.4	89.437636	**********
STD. DEV.	15.8	69.1	62.5	57.3	10.6	**********	62.3	10.6	9.457147	**********

****** = NO DATA

TABLE B-28. VOLATILE SUSPENDED SOLIDS CONCENTRATIONS DETERMINED DURING 1976

PARAMETER: VOLATILE SUSPENDED SOLIDS   UNITS: MG/L

DATE	STATION NUMBER 1	2	3	4	5	6	7	8	9	10
JUNE 23, 1976	********	********	********	********	8.5	126.6	********	********	1.2	******
JULY 1, 1976	30.1	28.8	71.0	16.9	19.7	247.1	********	8.5	0.8	******
JULY 7, 1976	31.0	14.9	33.1	14.8	********	********	********	********	******	******
JULY 8, 1976	********	********	********	********	15.5	43.9	********	********	0.8	******
JULY 13, 1976	24.3	37.1	51.1	13.0	********	********	********	********	******	******
JULY 14, 1976	********	********	********	15.7	********	********	9.9	8.3	******	******
JULY 15, 1976	********	********	********	********	10.5	107.7	********	5.9	1.5	******
JULY 22, 1976	32.3	29.3	45.0	12.3	15.4	20.7	10.7	33.7	0.9	******
JULY 29, 1976	50.0	8.5	51.2	13.8	15.7	28.3	34.1	9.6	0.9	******
AUG. 5, 1976	25.4	12.3	21.1	52.4	39.3	38.4	********	9.2	0.5	******
AUG. 12, 1976	22.6	22.0	21.4	16.5	20.3	221.2	********	20.6	5.3	******
AUG. 20, 1976	13.7	8.1	46.5	18.2	11.5	22.1	********	6.7	3.6	******
AUG. 27, 1976	7.1	10.2	8.6	51.3	********	********	********	18.3	1.2	******
SEP. 2, 1976	21.6	0.4	121.3	15.8	11.6	33.6	********	7.8	0.9	******
SEP. 10, 1976	39.3	8.6	12.1	10.5	********	********	********	********	4.1	******
SEP. 17, 1976	25.8	6.5	7.2	10.3	********	********	********	11.0	1.1	******
SEP. 24, 1976	23.0	4.8	4.7	2.3	********	********	********	8.3	0.2	******
OCT. 1, 1976	55.5	7.9	7.3	11.7	********	********	********	********	******	******
OCT. 8, 1976	62.0	11.5	10.1	5.9	********	********	********	********	******	******
OCT. 15, 1976	60.2	13.9	8.4	8.2	********	********	********	********	******	******
OCT. 22, 1976	66.8	12.4	12.1	13.3	********	********	********	********	******	******
MAXIMUM	66.8	37.1	121.3	52.4	39.3	247.1	34.1	33.7	5.3	*********
MINIMUM	7.1	0.4	4.7	2.3	8.5	20.7	9.9	5.9	0.2	*********
MEAN	34.7	14.0	31.2	16.8	16.8	89.0	18.2	12.0	1.6	*********
VARIANCE	317.8714	96.7763	954.5901	178.3986	77.2756	7191.6004	188.9733	62.4827	2.3396	*********
STD. DEV.	17.8289	9.8375	30.8965	13.3566	8.7907	84.8033	13.7468	7.9046	1.5296	*********

****** = NO DATA

TABLE B-29. VOLATILE SUSPENDED SOLIDS CONCENTRATIONS DETERMINED DURING 1977

PARAMETER: VOLATILE SUSPENDED SOLIDS UNITS: MG/L

DATE	STATION NUMBER 1	2	3	4	5	6	7	8	9	10
MAY 7, 1977	24.7	26.7	16.5	11.7	20.6	********	********	20.6	******	******
MAY 14, 1977	34.3	19.7	45.9	17.2	9.5	********	********	9.5	******	******
MAY 21, 1977	40.5	24.8	26.0	89.0	15.5	********	********	15.5	******	******
MAY 28, 1977	39.0	21.7	********	76.1	14.0	********	********	14.0	******	******
JUNE 7, 1977	52.7	36.0	42.6	31.3	24.5	********	********	24.5	******	******
JUNE 14, 1977	39.0	21.6	24.4	20.7	17.7	********	********	17.7	******	******
JUNE 21, 1977	12.0	133.3	9.2	24.1	0.0	********	********	0.0	3.1	******
JUNE 28, 1977	17.1	28.7	36.1	13.2	37.0	********	********	37.0	******	******
JULY 5, 1977	14.2	50.8	37.4	29.8	27.8	********	********	27.8	0.3	******
JULY 12, 1977	31.9	31.9	62.9	44.5	22.9	********	********	22.9	0.4	******
JULY 19, 1977	21.1	3.2	14.6	30.4	15.7	********	********	15.7	0.5	******
JULY 26, 1977	67.1	16.4	24.3	18.5	12.1	********	********	12.1	5.8	******
AUG. 2, 1977	3.3	19.4	19.3	7.6	9.6	********	********	9.6	1.5	******
AUG. 9, 1977	15.5	16.0	16.3	40.8	9.8	********	********	9.8	1.4	******
AUG. 16, 1977	36.8	28.0	15.1	12.4	15.1	********	********	15.1	2.5	******
AUG. 23, 1977	14.0	21.6	21.6	13.9	10.8	********	********	10.8	13.0	******
AUG. 30, 1977	9.3	1.7	19.4	6.8	0.0	********	********	0.0	0.0	******
SEP. 6, 1977	9.2	17.2	13.7	14.3	14.9	********	********	14.9	0.0	******
SEP. 13, 1977	13.1	8.5	11.7	10.6	6.4	********	21.4	6.4	******	******
SEP. 20, 1977	27.5	15.4	16.0	9.3	10.4	********	********	10.4	******	******
SEP. 27, 1977	15.0	17.1	12.4	19.4	5.1	********	********	5.1	******	******
SEP. 28, 1977	*********	********	********	17.2	********	********	24.4	*********	******	******
OCT. 5, 1977	11.8	13.8	12.3	13.3	16.2	********	********	16.2	******	******
MAXIMUM	67.1	133.3	62.9	89.0	37.0	**********	24.4	37.0	13.0	**********
MINIMUM	3.3	1.7	9.2	6.8	0.0	**********	21.4	0.0	0.0	**********
MEAN	25.0	26.1	23.7	24.9	14.3	**********	22.9	14.3	2.6	**********
VARIANCE	257.5702	687.7766	190.5550	435.4793	75.6455	**********	4.5000	75.6455	14.9369	**********
STD. DEV.	16.0490	26.2255	13.8042	20.8661	8.6974	**********	2.1213	8.6974	3.8648	**********

****** = NO DATA

TABLE B-30. SPECIFIC CONDUCTANCE CONCENTRATIONS DETERMINED DURING 1976

PARAMETER: SPECIFIC CONDUCTANCE   UNITS: MICROMHOS/CM

DATE	STATION NUMBER 1	2	3	4	5	6	7	8	9	10
MAY 19, 1976	********	********	********	********	1050.	1015.	********	********	******	******
MAY 22, 1976	********	********	********	********	******	******	********	********	464.	485.
MAY 29, 1976	********	********	********	********	1060.	1064.	********	********	435.	506.
JUNE 23, 1976	********	********	********	********	1099.	1130.	********	********	477.	******
JULY 1, 1976	1060.	1239.	1122.	1074.	1214.	1145.	********	1181.	507.	******
JULY 7, 1976	1054.	1048.	1035.	1054.	******	******	********	********	******	******
JULY 8, 1976	********	********	********	********	1096.	1112.	********	********	572.	******
JULY 13, 1976	1097.	1240.	1271.	1263.	******	******	********	********	******	******
JULY 14, 1976	********	********	********	1132.	******	******	1199.	1198.	******	******
JULY 15, 1976	********	********	********	********	1254.	1255.	********	1151.	526.	******
JULY 22, 1976	1166.	1102.	1115.	1169.	1142.	1157.	1208.	1174.	565.	******
JULY 29, 1976	1233.	1087.	1072.	1111.	1127.	1091.	1077.	1122.	485.	******
AUG. 5, 1976	1076.	1128.	1130.	1092.	1084.	1096.	********	1117.	516.	******
AUG. 12, 1976	1082.	1069.	1059.	1045.	1059.	1042.	********	1087.	477.	******
AUG. 20, 1976	1008.	1085.	1075.	1098.	1082.	1079.	********	1058.	478.	******
AUG. 27, 1976	1069.	1047.	1032.	1022.	******	******	********	1010.	498.	******
SEP. 2, 1976	1050.	1046.	983.	1098.	1084.	1088.	********	1073.	488.	******
SEP. 10, 1976	1012.	1045.	1012.	1029.	******	******	********	1007.	485.	******
SEP. 17, 1976	1069.	1092.	1075.	1069.	******	******	********	1052.	491.	******
SEP. 24, 1976	1082.	1058.	1078.	1115.	******	******	********	1090.	499.	******
OCT. 1, 1976	1123.	1163.	1029.	1216.	******	******	********	********	******	******
OCT. 8, 1976	951.	1064.	875.	1059.	******	******	********	********	******	******
OCT. 15, 1976	1288.	1087.	1062.	1036.	******	******	********	********	******	******
OCT. 22, 1976	1095.	905.	889.	888.	******	******	********	********	******	******
MAXIMUM	1288.	1240.	1271.	1263.	1254.	1255.	1208.	1198.	572.	506.
MINIMUM	951.	905.	875.	888.	1050.	1015.	1077.	1007.	435.	485.
MEAN	1090.	1089.	1054.	1087.	1113.	1106.	1161.	1102.	497.	496.
VARIANCE	6446.507	5973.015	8163.816	6583.124	3908.750	3859.424	5354.333	3899.936	1209.329	1860.500
STD. DEV.	80.290	77.285	90.354	81.136	62.520	62.124	73.173	62.449	34.775	43.134

****** = NO DATA

TABLE B-31. SPECIFIC CONDUCTANCE CONCENTRATIONS DETERMINED DURING 1977

PARAMETER: SPECIFIC CONDUCTANCE UNITS: MICROMHOS/CM

DATE	STATION NUMBER 1	2	3	4	5	6	7	8	9	10
MAY 14, 1977	1102.	1202.	1091.	1198.	1098.	******	*******	1098.	******	******
MAY 28, 1977	1108.	940.	*******	1208.	1143.	******	*******	1143.	******	******
JUNE 7, 1977	1285.	1202.	1169.	1203.	1244.	******	*******	1244.	******	******
JUNE 21, 1977	1239.	1157.	1271.	1173.	1174.	******	*******	1174.	490.	******
JULY 5, 1977	1159.	1128.	1108.	1129.	1134.	******	*******	1134.	481.	******
JULY 19, 1977	1259.	1126.	1091.	1044.	1106.	******	*******	1106.	466.	******
AUG. 2, 1977	1012.	992.	1005.	978.	971.	******	*******	971.	417.	******
AUG. 16, 1977	1098.	1055.	1050.	1060.	1050.	******	*******	1050.	449.	******
AUG. 30, 1977	1018.	970.	948.	949.	950.	******	*******	950.	430.	******
SEP. 13, 1977	1413.	1385.	1385.	1427.	1024.	******	1441.	1024.	******	******
SEP. 27, 1977	1077.	1098.	1040.	1085.	1085.	******	*******	1085.	******	******
SEP. 28, 1977	*******	*******	*******	1051.	******	******	1062.	*******	******	******
MAXIMUM	1413.	1385.	1385.	1427.	1244.	*********	1441.	1244.	490.	*********
MINIMUM	1012.	940.	948.	949.	950.	*********	1062.	950.	417.	*********
MEAN	1161.	1114.	1116.	1125.	1089.	*********	1252.	1089.	456.	*********
VARIANCE	15453.691	16075.091	16798.400	16570.083	7556.800	*********	71820.500	7556.800	825.100	*********
STD. DEV.	124.313	126.788	129.609	128.725	86.930	*********	267.993	86.930	28.725	*********

****** = NO DATA

TABLE B-32. SULFATE CONCENTRATIONS DETERMINED DURING 1976

PARAMETER: SULFATE   UNITS: MG/L

DATE	STATION NUMBER 1	2	3	4	5	6	7	8	9	10
MAY 19, 1976	*********	*******	*******	********	67.0	59.1	*******	********	******	******
MAY 22, 1976	*********	*******	*******	********	*******	*******	*******	********	20.3	17.6
MAY 29, 1976	*********	*******	*******	********	66.0	72.0	*******	********	25.0	29.0
JUNE 23, 1976	*********	*******	*******	********	134.0	121.6	*******	********	35.4	******
JULY 1, 1976	55.8	63.0	59.0	51.3	52.1	59.3	*******	59.3	10.4	******
JULY 7, 1976	68.4	67.0	63.	63.7	*******	*******	*******	********	******	******
JULY 8, 1976	*********	*******	*******	********	62.3	62.3	*******	********	20.3	******
JULY 13, 1976	69.0	61.0	62.3	61.9	*******	*******	*******	********	******	******
JULY 14, 1976	*********	*******	*******	64.3	*******	*******	64.3	66.4	******	******
JULY 15, 1976	*********	*******	*******	********	64.3	60.0	*******	61.2	20.1	******
JULY 22, 1976	56.8	53.8	53.8	56.3	53.8	63.0	55.0	55.8	21.3	******
JULY 29, 1976	58.3	61.3	65.3	60.0	68.3	65.0	66.5	62.0	22.6	******
AUG. 5, 1976	58.8	58.8	57.5	58.5	59.0	56.3	*******	56.0	19.3	******
AUG. 12, 1976	60.3	75.4	69.4	60.3	65.0	63.5	*******	70.9	32.7	******
AUG. 20, 1976	50.3	53.8	55.5	50.8	49.8	52.8	*******	54.0	39.1	******
AUG. 27, 1976	52.3	53.6	54.4	53.2	*******	*******	*******	52.9	14.5	******
SEP. 2, 1976	59.5	59.5	64.5	62.5	60.5	63.0	*******	67.0	14.0	******
OCT. 1, 1976	58.3	55.8	59.0	62.8	*******	*******	*******	********	******	******
OCT. 15, 1976	62.3	61.8	60.5	60.8	*******	*******	*******	********	******	******
MAXIMUM	69.0	75.4	69.4	64.3	134.0	121.6	66.5	70.9	39.1	29.0
MINIMUM	50.3	53.6	53.8	50.8	49.8	52.8	55.0	52.9	10.4	17.6
MEAN	59.2	60.4	60.4	59.0	66.8	66.5	61.9	60.6	22.7	23.3
VARIANCE	30.68205	39.66727	22.55182	21.57436	483.91902	323.65720	37.26333	36.85833	71.79744	64.98000
STD. DEV.	5.53914	6.29820	4.74888	4.64482	21.99816	17.99048	6.10437	6.07111	8.47334	8.06102

****** = NO DATA

TABLE B-33. SULFATE CONCENTRATIONS DETERMINED DURING 1977

PARAMETER: SULFATE

UNITS: [illegible]

DATE	STATION NUMBER 1	2	3	4	5	6	7	8	9	10
MAY 28, 1977	65.0	70.6	********	65.4	59.6	********	********	59.6	******	******
JUNE 7, 1977	73.8	67.2	75.8	76.3	69.3	********	********	69.3	******	******
JULY 5, 1977	68.4	69.7	67.1	71.1	72.4	********	********	72.4	14.7	******
AUG. 2, 1977	61.0	82.9	63.4	65.9	68.3	********	********	68.3	20.9	******
AUG. 30, 1977	57.6	50.2	52.2	50.0	54.4	********	********	54.3	19.8	******
SEP. 13, 1977	50.0	64.3	71.4	65.5	64.3	********	78.3	64.3	******	******
SEP. 27, 1977	61.5	60.7	60.2	58.0	59.6	********	********	59.6	******	******
SEP. 28, 1977	*********	********	********	57.5	********	********	61.2	*********	******	******
MAXIMUM	73.8	82.9	75.8	76.3	72.4	**********	78.3	72.4	20.9	**********
MINIMUM	50.0	50.2	52.2	50.0	54.4	**********	61.2	54.3	14.7	**********
MEAN	62.5	66.5	65.0	63.7	64.0	**********	69.8	64.0	18.5	**********
VARIANCE	58.70905	100.11143	70.28967	69.01554	41.35143	**********	146.20500	41.67238	10.94333	**********
STD. DEV.	7.66218	10.00557	8.38389	8.30756	6.43051	**********	12.09153	6.45541	3.30807	**********

****** = NO DATA

TABLE B-34. BIOCHEMICAL OXYGEN DEMAND CONCENTRATIONS DETERMINED DURING 1976

PARAMETER: BIOCHEMICAL OXYGEN DEMAND UNITS: MG/L

DATE	STATION NUMBER 1	2	3	4	5	6	7	8	9	10
MAY 19, 1976	*********	********	********	*********	21.6	19.8	********	*********	******	******
MAY 22, 1976	*********	********	********	*********	********	********	********	*********	2.1	3.9
MAY 29, 1976	*********	********	********	*********	11.4	21.0	********	*********	2.3	4.5
JUNE 23, 1976	*********	********	********	*********	6.3	17.8	********	*********	3.7	******
JULY 1, 1976	36.4	6.7	17.7	15.5	8.4	24.7	********	6.6	1.4	******
JULY 7, 1976	46.0	8.0	22.9	19.6	********	********	********	*********	******	******
JULY 8, 1976	*********	********	********	*********	27.5	26.0	********	*********	1.5	******
JULY 13, 1976	36.3	12.2	10.3	12.6	********	********	********	*********	******	******
JULY 14, 1976	*********	********	********	7.5	********	********	13.8	7.2	******	******
JULY 15, 1976	*********	********	********	*********	9.7	22.3	********	6.0	1.3	******
JULY 22, 1976	22.9	13.7	40.5	11.0	11.2	14.5	12.3	14.8	0.9	******
JULY 29, 1976	15.3	7.3	16.0	12.5	9.4	13.6	11.2	9.5	0.5	******
AUG. 5, 1976	24.0	5.0	13.9	28.5	9.7	9.7	********	11.7	0.3	******
AUG. 12, 1976	33.8	17.2	18.3	17.0	14.3	15.2	********	21.7	1.5	******
AUG. 20, 1976	22.1	12.3	16.5	15.6	9.6	11.3	********	13.4	1.0	******
AUG. 27, 1976	25.1	10.5	17.4	14.6	********	********	********	22.0	4.2	******
SEP. 2, 1976	28.6	10.1	********	10.1	6.5	10.4	********	14.1	1.2	******
SEP. 10, 1976	34.2	11.1	16.1	12.5	********	********	********	11.9	1.1	******
SEP. 17, 1976	23.5	10.9	15.0	10.9	********	********	********	14.2	1.6	******
SEP. 24, 1976	31.0	10.3	11.6	14.4	********	********	********	27.3	0.8	******
OCT. 1, 1976	26.8	13.9	13.7	*********	********	********	********	*********	******	******
OCT. 8, 1976	32.8	11.6	9.9	9.0	********	********	********	*********	******	******
OCT. 15, 1976	32.7	13.7	19.4	13.8	********	********	********	*********	******	******
OCT. 22, 1976	24.7	17.4	13.7	14.4	********	********	********	*********	******	******
MAXIMUM	46.0	17.4	40.5	28.5	27.5	26.0	13.8	27.3	4.2	4.5
MINIMUM	15.3	5.0	9.9	7.5	6.3	9.7	11.2	6.0	0.3	3.9
MEAN	29.0	11.3	17.1	14.1	12.1	17.2	12.4	13.9	1.6	4.2
VARIANCE	54.055147	11.461250	50.467958	22.721103	39.753333	31.164470	1.703333	41.331923	1.123833	0.180000
STD. DEV.	7.352221	3.385447	7.104080	4.766666	6.305024	5.582515	1.305118	6.428991	1.060110	0.424264

****** = NO DATA

TABLE B-35. BIOCHEMICAL OXYGEN DEMAND CONCENTRATIONS DETERMINED DURING 1977

PARAMETER: BIOCHEMICAL OXYGEN DEMAND   UNITS: MG/L

DATE	STATION NUMBER 1	2	3	4	5	6	7	8	9	10
MAY 7, 1977	15.5	15.8	11.2	10.5	12.2	********	********	12.2	******	******
MAY 14, 1977	14.1	9.7	16.0	8.1	9.0	********	********	9.0	******	******
MAY 21, 1977	16.5	8.2	19.0	12.5	10.8	********	********	10.8	******	******
MAY 28, 1977	8.7	10.2	********	35.4	13.9	********	********	13.9	******	******
JUNE 14, 1977	20.4	13.6	9.5	12.1	9.0	********	********	9.0	******	******
JUNE 21, 1977	19.0	33.8	10.8	10.4	7.3	********	********	7.3	******	******
JUNE 28, 1977	11.4	12.8	10.3	8.1	9.7	********	********	9.7	******	******
JULY 5, 1977	13.8	19.1	20.1	27.8	15.5	********	********	15.5	******	******
JULY 12, 1977	18.7	29.7	23.9	26.7	24.3	********	********	24.3	1.7	******
JULY 19, 1977	12.4	10.2	13.0	9.5	11.3	********	********	11.3	2.6	******
JULY 26, 1977	19.5	35.7	12.4	8.3	15.1	********	********	15.1	2.9	******
AUG. 2, 1977	16.1	12.6	14.3	15.0	13.6	********	********	13.6	1.2	******
AUG. 9, 1977	36.2	11.6	9.9	35.3	7.7	********	********	7.7	2.0	******
AUG. 16, 1977	13.8	33.0	31.7	28.6	29.8	********	********	29.8	1.7	******
AUG. 23, 1977	10.1	14.7	11.1	9.2	13.4	********	********	13.4	7.0	******
AUG. 30, 1977	13.7	21.9	8.8	9.3	10.6	********	********	10.8	******	******
SEP. 6, 1977	15.3	33.1	17.9	12.0	13.0	********	********	13.0	0.6	******
SEP. 13, 1977	8.6	6.5	15.9	8.4	10.9	********	18.5	10.9	3.1	******
SEP. 20, 1977	17.0	17.9	12.4	9.1	14.0	********	********	14.0	******	******
SEP. 27, 1977	13.8	10.4	11.0	21.6	7.6	********	********	7.6	******	******
OCT. 5, 1977	20.4	15.4	14.2	17.2	23.0	********	********	23.0	******	******
MAXIMUM	36.2	35.7	31.7	35.4	29.8	**********	18.5	29.8	7.0	**********
MINIMUM	8.6	6.5	8.8	8.1	7.3	**********	18.5	7.3	0.6	**********
MEAN	16.0	17.9	14.7	16.0	13.4	**********	18.5	13.4	2.5	**********
VARIANCE	33.882619	89.234000	31.952211	86.151871	33.524286	**********	**********	33.524286	3.450000	**********
STD. DEV.	5.820878	9.446375	5.652629	9.281787	5.790016	**********	**********	5.790016	1.857418	**********

****** = NO DATA

TABLE B-36. CHEMICAL OXYGEN DEMAND CONCENTRATIONS DETERMINED DURING 1976

PARAMETER: CHEMICAL OXYGEN DEMAND UNITS: MG/L

DATE	STATION NUMBER									
	1	2	3	4	5	6	7	8	9	10
MAY 19, 1976	*********	********	********	*********	95.7	*******	********	*********	*******	*******
MAY 22, 1976	*********	********	********	*********	*******	*******	********	*********	39.43	187.7
MAY 29, 1976	*********	********	********	*********	60.2	862.7	********	*********	12.82	175.1
JUNE 23, 1976	*********	********	********	*********	59.1	240.0	********	*********	9.87	*******
JULY 1, 1976	149.9	131.3	240.8	82.2	69.4	289.7	********	51.9	5.49	*******
JULY 7, 1976	92.4	66.7	99.2	62.2	*******	*******	********	*********	*******	*******
JULY 8, 1976	*********	********	********	*********	63.9	59.8	********	*********	4.08	*******
JULY 13, 1976	102.9	89.1	111.1	56.1	*******	*******	********	*********	*******	*******
JULY 14, 1976	*********	********	********	53.3	*******	*******	62.1	53.1	*******	*******
JULY 15, 1976	*********	********	********	*********	58.8	101.4	********	*********	13.38	*******
JULY 22, 1976	113.2	87.7	112.2	54.8	49.9	159.7	63.8	85.3	6.82	*******
JULY 29, 1976	122.1	57.3	150.0	62.8	56.7	106.7	62.0	56.8	8.15	*******
AUG. 5, 1976	97.8	55.8	72.9	58.0	79.3	61.2	********	59.1	0.71	*******
AUG. 12, 1976	83.4	58.6	57.2	57.2	54.6	106.8	********	71.5	6.92	*******
AUG. 20, 1976	81.2	47.5	75.1	60.4	40.5	42.8	********	48.2	12.69	*******
AUG. 27, 1976	100.7	44.1	50.6	39.9	*******	*******	********	52.2	8.97	*******
SEP. 2, 1976	72.5	41.2	73.4	41.7	33.6	53.5	********	42.5	2.74	*******
SEP. 10, 1976	89.2	42.5	37.0	35.0	*******	*******	********	44.2	14.10	*******
SEP. 17, 1976	77.3	37.0	34.6	37.2	*******	*******	********	41.7	1.47	*******
SEP. 24, 1976	77.5	38.1	38.1	37.1	*******	*******	********	60.0	6.07	*******
OCT. 1, 1976	93.0	45.5	34.8	53.8	*******	*******	********	*********	*******	*******
OCT. 9, 1976	150.0	56.6	38.5	41.9	*******	*******	********	*********	*******	*******
OCT. 15, 1976	144.0	57.7	50.3	48.3	*******	*******	********	*********	*******	*******
OCT. 22, 1976	155.9	61.8	58.2	53.9	*******	*******	********	*********	*******	*******
MAXIMUM	155.9	131.3	240.8	82.2	95.7	862.7	63.8	85.3	39.4	187.70
MINIMUM	72.5	37.0	34.6	35.0	33.6	42.8	62.0	41.7	0.7	175.10
MEAN	106.1	59.9	78.5	52.0	60.1	196.8	62.6	55.5	9.5	181.40
VARIANCE	795.834	567.321	2836.258	141.045	270.170	55402.227	1.023	158.995	81.574	79.380
STD. DEV.	28.211	23.819	53.257	11.876	16.437	235.377	1.012	12.609	9.032	8.910

****** = NO DATA

TABLE B-37. CHEMICAL OXYGEN DEMAND CONCENTRATIONS DETERMINED DURING 1977

PARAMETER: CHEMICAL OXYGEN DEMAND UNITS: MG/

DATE	STATION NUMBER 1	2	3	4	5	6	7	8	9	10
MAY 28, 1977	77.9	61.9	*******	117.2	60.6	******	*******	60.6	******	******
JUNE 21, 1977	58.3	172.6	55.7	57.8	44.4	******	*******	44.4	20.58	******
JULY 5, 1977	71.3	98.2	68.8	76.7	95.1	******	*******	95.1	0.00	******
JULY 19, 1977	154.0	78.6	100.6	62.1	94.3	******	*******	94.3	7.86	******
AUG. 2, 1977	83.0	70.6	100.8	86.1	84.5	******	*******	84.5	69.00	******
AUG. 16, 1977	76.2	82.3	74.0	51.6	52.8	******	*******	52.8	17.20	******
AUG. 30, 1977	42.7	49.3	39.9	33.0	29.8	******	*******	29.8	11.49	******
SEP '3, 1977	40.6	29.7	26.6	27.1	41.8	******	62.5	41.8	******	******
SEP. 27, 1977	56.6	55.6	44.1	55.2	40.8	******	*******	40.8	******	******
SEP. 28, 1977	********	*******	*******	51.1	******	******	72.3	********	******	******
MAXIMUM	154.0	172.6	100.8	117.2	95.1	**********	72.3	95.1	69.0	**********
MINIMUM	40.6	29.7	26.6	27.1	29.8	**********	62.5	29.8	0.0	**********
MEAN	73.4	77.6	63.8	61.8	60.5	**********	67.4	60.5	21.0	**********
VARIANCE	1143.700	1668.403	751.576	688.152	614.295	**********	48.020	614.295	604.543	**********
STD. DEV.	33.819	40.846	27.415	26.233	24.785	**********	6.930	24.785	24.587	**********

****** = NO DATA

TABLE B-38. TEMPERATURE CONCENTRATIONS DETERMINED DURING 1976.

PARAMETER: TEMPERATURE

UNITS: DEGREES CELSIUS

DATE	STATION NUMBER 1	2	3	4	5	6	7	8	9	10
MAY 22, 1976	********	*******	*******	********	*******	*******	*******	********	11.0	12.0
MAY 29, 1976	********	*******	*******	********	20.0	20.0	*******	********	12.0	18.0
JULY 1, 1976	********	*******	*******	********	19.0	22.0	*******	********	******	******
JULY 6, 1976	22.0	*******	*******	********	*******	*******	*******	********	******	******
JULY 12, 1976	20.0	21.0	*******	********	*******	*******	*******	********	******	******
JULY 13, 1976	20.0	*******	*******	********	*******	*******	*******	********	******	******
JULY 22, 1976	22.0	*******	*******	********	21.0	24.0	21.0	********	******	******
JULY 29, 1976	23.0	23.0	*******	********	24.0	25.0	*******	********	20.0	******
AUG. 5, 1976	20.0	24.0	24.0	19.0	19.0	22.0	*******	22.0	13.0	******
AUG. 12, 1976	21.0	23.0	23.0	20.0	20.0	23.0	*******	19.0	17.0	******
AUG. 20, 1976	21.0	23.0	24.0	21.0	22.0	23.0	*******	15.0	11.0	******
SEP. 2, 1976	27.0	*******	22.0	20.0	*******	19.0	*******	26.0	22.0	******
SEP. 10, 1976	21.0	20.0	19.0	19.0	*******	*******	*******	19.0	18.0	******
SEP. 16, 1976	21.0	19.0	20.0	20.0	*******	*******	*******	********	******	******
SEP. 17, 1976	21.0	20.0	20.0	19.0	*******	*******	*******	17.0	17.0	******
SEP. 23, 1976	19.0	17.0	19.0	20.0	*******	*******	*******	********	******	******
SEP. 24, 1976	20.0	19.0	20.0	19.0	*******	*******	*******	19.0	22.0	******
SEP. 30, 1976	20.0	21.0	21.0	17.0	*******	*******	*******	********	******	******
OCT. 1, 1976	20.0	19.0	20.0	18.0	*******	*******	*******	********	******	******
OCT. 7, 1976	17.0	17.0	16.0	14.0	*******	*******	*******	********	******	******
OCT. 8, 1976	19.0	18.0	17.0	16.0	*******	*******	*******	********	******	******
OCT. 14, 1976	15.0	15.0	16.0	15.0	*******	*******	*******	********	******	******
OCT. 15, 1976	19.0	16.0	16.0	17.0	*******	*******	*******	********	******	******
OCT. 21, 1976	15.0	14.0	14.0	12.0	*******	*******	*******	********	******	******
OCT. 22, 1976	16.0	14.0	13.0	13.0	*******	*******	*******	********	******	******
MAXIMUM	27.0	24.0	24.0	21.0	24.0	25.0	21.0	26.0	22.0	18.0
MINIMUM	15.0	14.0	13.0	12.0	19.0	19.0	21.0	15.0	11.0	12.0
MEAN	20.0	19.1	19.1	17.6	20.7	22.3	21.0	19.6	16.3	15.0
VARIANCE	7.093074	9.820261	10.933824	7.382353	3.238095	3.928571	**********	12.619048	18.677778	18.000000
STD. DEV.	2.663282	3.133730	3.306633	2.717049	1.799471	1.982062	**********	3.552330	4.321779	4.242641

****** = NO DATA

TABLE B-39. TEMPERATURE CONCENTRATIONS DETERMINED DURING 1977

PARAMETER: TEMPERATURE   UNITS: DEGREES CELSIUS

DATE	STATION NUMBER 1	2	3	4	5	6	7	8	9	10
MAY 7, 1977	13.0	12.5	12.5	11.0	*******	********	********	********	******	******
MAY 14, 1977	12.5	12.0	12.5	11.9	11.5	********	********	11.5	******	******
MAY 21, 1977	12.0	14.0	15.5	14.0	13.5	********	********	13.5	******	******
MAY 28, 1977	14.5	16.5	*******	12.5	16.0	********	********	16.0	******	******
JUNE 7, 1977	20.0	27.0	29.0	21.0	22.5	********	********	22.5	******	******
JUNE 14, 1977	********	20.0	18.8	19.5	20.0	********	********	20.0	******	******
JUNE 21, 1977	20.0	24.0	26.0	21.0	22.5	********	********	22.5	******	******
JUNE 28, 1977	21.0	26.0	28.0	23.0	25.5	********	********	25.5	******	******
JULY 5, 1977	20.0	24.0	24.0	22.0	23.0	********	********	23.0	21.0	******
JULY 12, 1977	19.5	24.5	25.0	20.5	22.0	********	********	22.0	26.5	******
JULY 19, 1977	21.2	23.8	23.5	21.8	22.0	********	********	22.0	25.0	******
JULY 26, 1977	20.5	25.0	25.0	20.0	22.5	********	********	22.5	******	******
AUG. 2, 1977	20.0	25.0	24.0	20.0	24.0	********	********	24.0	34.0	******
AUG. 9, 1977	21.0	25.0	24.0	25.5	23.0	********	********	23.0	32.5	******
AUG. 16, 1977	22.0	27.0	24.0	19.0	25.5	********	********	25.5	37.5	******
AUG. 23, 1977	22.0	23.5	22.0	20.5	22.0	********	********	22.0	******	******
AUG. 30, 1977	21.0	22.5	21.0	19.5	21.0	********	********	21.0	28.0	******
SEP. 13, 1977	18.2	20.1	18.0	19.0	23.4	********	24.0	23.4	******	******
SEP. 20, 1977	17.3	15.4	14.8	14.0	15.9	********	********	15.9	******	******
SEP. 27, 1977	19.5	20.1	19.0	18.1	19.7	********	********	19.7	******	******
OCT. 5, 1977	17.0	16.0	16.0	15.5	16.0	********	********	16.0	******	******
MAXIMUM	22.0	27.0	29.0	25.5	25.5	**********	24.0	25.5	37.5	**********
MINIMUM	12.0	12.0	12.5	11.0	11.5	**********	24.0	11.5	21.0	**********
MEAN	18.6	21.1	21.1	18.5	20.6	**********	24.0	20.6	29.2	**********
VARIANCE	10.188316	23.633476	24.681158	15.266476	15.505132	**********	**********	15.505132	32.738095	**********
STD. DEV.	3.191914	4.861427	4.968013	3.907234	3.937656	**********	**********	3.937656	5.721721	**********

****** = NO DATA

TABLE B-40. DISSOLVED OXYGEN CONCENTRATIONS DETERMINED DURING 1976

PARAMETER: DISSOLVED OXYGEN   UNITS: MG/L

DATE	STATION NUMBER 1	2	3	4	5	6	7	8	9	10
MAY 19, 1976	********	*******	*******	********	6.8	6.8	*******	********	******	******
MAY 22, 1976	********	*******	*******	********	*******	*******	*******	********	9.5	9.0
MAY 29, 1976	********	*******	*******	********	4.9	6.7	*******	********	9.4	8.2
JUNE 23, 1976	********	*******	*******	********	2.1	5.1	*******	********	8.8	******
JULY 1, 1976	********	*******	*******	********	4.4	6.4	*******	********	******	******
JULY 6, 1976	5.4	*******	*******	********	*******	*******	*******	********	******	******
JULY 12, 1976	6.8	5.9	*******	********	*******	*******	*******	********	******	******
JULY 13, 1976	6.8	*******	*******	********	*******	*******	*******	********	******	******
JULY 21, 1976	********	*******	*******	8.5	*******	*******	5.2	********	******	******
JULY 22, 1976	4.7	*******	*******	********	8.5	7.0	*******	********	******	******
JULY 29, 1976	********	4.9	*******	********	20.0	20.0	*******	********	7.2	******
AUG. 12, 1976	5.9	7.8	3.6	6.9	9.6	8.7	*******	6.4	7.0	******
AUG. 20, 1976	5.7	4.1	3.1	7.7	7.1	7.3	*******	5.2	5.8	******
SEP. 2, 1976	5.4	2.7	2.2	4.2	4.0	6.1	*******	0.7	8.1	******
SEP. 10, 1976	5.7	1.8	4.0	5.3	*******	*******	*******	5.0	7.5	******
SEP. 16, 1976	5.5	1.6	3.3	8.6	*******	*******	*******	********	******	******
SEP. 17, 1976	5.9	1.5	3.8	7.4	*******	*******	*******	5.2	7.8	******
SEP. 23, 1976	6.0	1.9	4.0	6.6	*******	*******	*******	********	******	******
SEP. 24, 1976	5.6	2.0	4.0	4.7	*******	*******	*******	5.3	9.7	******
SEP. 30, 1976	5.4	3.6	3.3	4.5	*******	*******	*******	********	******	******
OCT. 1, 1976	5.7	3.7	3.8	3.8	*******	*******	*******	********	******	******
OCT. 7, 1976	6.1	7.4	4.4	6.9	*******	*******	*******	********	******	******
OCT. 8, 1976	6.3	8.0	4.6	8.8	*******	*******	*******	********	******	******
OCT. 14, 1976	6.7	9.6	5.8	8.0	*******	*******	*******	********	******	******
OCT. 15, 1976	6.3	11.2	5.7	6.2	*******	*******	*******	********	******	******
OCT. 21, 1976	5.8	7.9	5.8	6.0	*******	*******	*******	********	******	******
OCT. 22, 1976	6.3	6.3	5.3	7.0	*******	*******	*******	********	******	******
MAXIMUM	6.8	11.2	5.8	8.8	20.0	20.0	5.2	6.4	9.7	9.0
MINIMUM	4.7	1.5	2.2	3.8	2.1	5.1	5.2	0.7	5.8	8.2
MEAN	5.9	5.1	4.2	6.5	7.5	8.2	5.2	4.6	8.1	8.6
VARIANCE	0.282105	9.137026	1.092958	2.522426	27.511111	20.400000	**********	3.962667	1.606222	0.320000
STD. DEV.	0.531136	3.022751	1.045446	1.588215	5.245104	4.516636	**********	1.990645	1.267368	0.565685

****** = NO DATA

TABLE B-41. DISSOLVED OXYGEN CONCENTRATIONS DETERMINED DURING 1977

PARAMETER: DISSOLVED OXYGEN UNITS: MG/L

DATE	STATION NUMBER									
	1	2	3	4	5	6	7	8	9	10
MAY 7, 1977	7.2	10.0	10.1	20.0	7.8	********	********	7.8	******	******
MAY 14, 1977	9.1	16.2	12.8	8.9	3.4	********	********	3.4	******	******
MAY 28, 1977	7.1	13.8	********	0.5	8.9	********	********	8.9	******	******
JUNE 7, 1977	5.5	1.7	6.6	0.4	0.9	********	********	0.9	******	******
JUNE 14, 1977	7.3	3.3	4.2	3.2	1.3	********	********	1.3	******	******
JUNE 21, 1977	5.6	5.0	4.5	13.8	1.9	********	********	1.9	******	******
JUNE 28, 1977	4.9	17.1	4.8	1.8	7.9	********	********	7.9	******	******
JULY 5, 1977	5.8	18.2	5.8	13.8	12.4	********	********	12.4	******	******
JULY 12, 1977	5.9	16.0	2.0	10.4	6.7	********	********	6.7	8.9	******
JULY 19, 1977	5.2	9.0	1.9	14.0	7.3	********	********	7.3	8.7	******
JULY 26, 1977	5.1	7.8	2.0	8.2	2.4	********	********	2.4	6.6	******
AUG. 2, 1977	5.7	8.5	1.6	4.1	4.8	********	********	4.8	******	******
AUG. 9, 1977	5.5	11.8	20.0	16.4	5.3	********	********	5.3	2.0	******
AUG. 16, 1977	5.9	6.7	6.4	3.0	6.2	********	********	6.2	3.0	******
AUG. 23, 1977	7.2	11.2	4.0	4.2	4.9	********	********	4.9	3.7	******
AUG. 30, 1977	20.0	6.9	3.6	12.0	3.1	********	********	3.1	******	******
SEP. 6, 1977	********	********	********	********	********	********	********	********	3.1	******
SEP. 13, 1977	9.2	6.1	4.2	6.7	3.2	********	5.4	3.2	******	******
SEP. 20, 1977	7.6	4.7	3.2	4.4	3.1	********	********	3.1	******	******
SEP. 27, 1977	5.4	4.7	2.7	12.6	3.2	********	********	3.2	******	******
OCT. 5, 1977	5.2	8.0	3.4	7.2	4.4	********	********	4.4	******	******
MAXIMUM	20.0	18.2	20.0	20.0	12.4	**********	5.4	12.4	8.9	**********
MINIMUM	4.9	1.7	1.6	0.4	0.9	**********	5.4	0.9	2.0	**********
MEAN	7.0	9.3	5.5	8.3	5.0	**********	5.4	5.0	5.1	**********
VARIANCE	10.939579	23.427658	20.429123	31.866947	8.391026	**********	**********	8.391026	8.269524	**********
STD. DEV.	3.307503	4.840213	4.519859	5.645082	2.896727	**********	**********	2.896727	2.875678	**********

****** = NO DATA

TABLE B-42. PH CONCENTRATIONS DETERMINED DURING 1976

PARAMETER: PH

UNITS: PH UNITS

DATE	STATION NUMBER 1	2	3	4	5	6	7	8	9	10
MAY 29, 1976	*********	********	********	*********	6.5	6.5	********	*********	7.0	7.0
JUNE 23, 1976	*********	********	********	*********	7.0	********	********	*********	7.0	7.0
JULY 1, 1976	*********	********	********	*********	7.7	7.7	********	*********	*******	*******
JULY 7, 1976	7.5	********	********	*********	********	********	********	*********	*******	*******
JULY 13, 1976	7.3	********	********	*********	********	********	********	*********	*******	*******
JULY 21, 1976	*********	********	********	8.8	8.8	8.6	8.3	*********	*******	*******
JULY 22, 1976	7.2	********	********	*********	********	********	********	*********	*******	*******
JULY 29, 1976	7.5	7.6	********	*********	8.0	8.0	********	*********	7.6	*******
AUG. 5, 1976	7.1	7.4	7.7	7.5	7.5	7.7	********	7.6	7.4	*******
AUG. 12, 1976	7.0	7.5	7.5	8.0	7.6	7.9	********	7.7	7.6	*******
AUG. 20, 1976	7.0	7.5	7.4	7.8	7.8	7.9	********	7.6	7.9	*******
SEP. 23, 1976	7.6	7.5	7.8	7.9	********	********	********	*********	*******	*******
SEP. 24, 1976	7.5	7.6	7.8	7.8	********	********	********	7.7	7.5	*******
SEP. 30, 1976	7.3	7.6	7.7	7.7	********	********	********	*********	*******	*******
OCT. 1, 1976	7.6	7.6	7.8	7.7	********	********	********	*********	*******	*******
OCT. 7, 1976	7.3	7.8	7.8	7.8	********	********	********	*********	*******	*******
OCT. 8, 1976	7.5	7.6	7.7	7.9	********	********	********	*********	*******	*******
OCT. 14, 1976	7.3	7.7	7.7	7.9	********	********	********	*********	*******	*******
OCT. 15, 1976	7.5	8.0	7.8	7.9	********	********	********	*********	*******	*******
OCT. 21, 1976	7.5	7.5	7.6	7.6	********	********	********	*********	*******	*******
OCT. 22, 1976	7.5	7.5	7.7	7.8	********	********	********	*********	*******	*******
MAXIMUM	7.6	8.0	7.8	8.8	8.8	8.6	8.3	7.7	7.9	7.0
MINIMUM	7.0	7.4	7.4	7.5	6.5	6.5	8.3	7.6	7.0	7.0
MEAN	7.4	7.6	7.7	7.9	7.6	7.8	8.3	7.7	7.4	7.0
VARIANCE	.03867647	.02307692	.01576923	.09016483	.46125000	.39952381	*********	.00333333	.10333333	.00000000
STD. DEV.	.19666334	.15191091	.12557560	.30027460	.67915389	.63207896	*********	.05773503	.32145503	.00000000

****** = NO DATA

TABLE B-43. PH CONCENTRATIONS DETERMINED DURING 1977

PARAMETER: PH   UNITS: PH UNITS

DATE	STATION NUMBER 1	2	3	4	5	6	7	8	9	10
MAY 7, 1977	7.6	7.9	8.1	8.3	8.4	*******	*******	8.4	******	******
MAY 14, 1977	7.5	7.9	8.1	7.7	6.9	*******	*******	6.9	******	******
MAY 21, 1977	7.3	7.1	7.9	7.5	7.1	*******	*******	7.1	******	******
MAY 28, 1977	7.[illegible]	7.6	*******	7.3	6.7	*******	*******	6.7	******	******
JUNE 7, 1977	7.0	7.2	7.5	7.4	7.0	*******	*******	7.0	******	******
JUNE 21, 1977	6.4	7.1	7.5	7.9	7.7	*******	*******	7.7	******	******
JUNE 28, 1977	6.[illegible]	8.3	7.8	7.2	7.8	*******	*******	7.8	******	******
JULY 5, 1977	6.3	8.5	7.9	8.4	7.5	*******	*******	7.5	8.1	******
JULY 12, 1977	7.0	8.3	7.3	8.4	6.1	*******	*******	6.1	7.0	******
JULY 19, 1977	6.[illegible]	6.4	6.5	6.7	6.7	*******	*******	6.7	6.3	******
AUG. 2, 1977	6.9	8.0	7.4	7.7	7.7	*******	*******	7.7	7.6	******
AUG. 9, 1977	6.6	8.1	7.2	8.0	7.0	*******	*******	7.0	7.2	******
AUG. 16, 1977	6.6	7.5	7.4	7.0	7.2	*******	*******	7.2	7.3	******
AUG. 23, 1977	7.3	7.4	7.4	7.6	7.4	*******	*******	7.4	******	******
AUG. 30, 1977	6.2	7.8	7.6	7.8	7.6	*******	*******	7.6	7.8	******
SEP. 27, 1977	6.7	7.1	7.2	8.1	6.9	*******	*******	6.9	******	******
MAXIMUM	7.6	8.5	8.1	8.4	8.4	*********	*********	8.4	8.1	*********
MINIMUM	6.1	6.4	6.5	6.7	6.1	*********	*********	6.1	6.3	*********
MEAN	6.8	7.6	7.5	7.7	7.2	*********	*********	7.2	7.3	*********
VARIANCE	.22116667	.31983333	.17028571	.24516667	.30362500	*********	*********	.30362500	.34571429	*********
STD. DEV.	.47028360	.56553809	.41265609	.49514308	.55102178	*********	*********	.55102178	.58797473	*********

****** = NO DATA

TABLE B-44. ALUMINUM CONCENTRATIONS DETERMINED DURING 1976

PARAMETER: ALUMINUM UNITS: MICROGRAMS/L

DATE	STATION NUMBER 1	2	3	4	5	6	7	8	9	10
MAY 19, 1976	*********	********	********	*********	200.	380.	********	*********	******	******
MAY 22, 1976	*********	********	********	*********	******	******	********	*********	220.	300.
MAY 29, 1976	*********	********	********	*********	170.	230.	********	*********	220.	360.
JUNE 23, 1976	*********	********	********	*********	100.	100.	********	*********	90.	******
JULY 1, 1976	100.	120.	160.	90.	150.	130.	********	60.	130.	******
JULY 7, 1976	90.	60.	140.	100.	******	******	********	*********	******	******
JULY 8, 1976	*********	********	********	*********	130.	110.	********	*********	110.	******
MAXIMUM	100.	120.	160.	100.	200.	380.	**********	60.	220.	360.
MINIMUM	90.	60.	140.	90.	100.	100.	**********	60.	90.	300.
MEAN	95.	90.	150.	95.	150.	190.	**********	60.	154.	330.
VARIANCE	50.000	1800.000	200.000	50.000	1450.000	13950.000	**********	**********	3830.000	1800.000
STD. DEV.	7.071	42.426	14.142	7.071	38.079	118.110	**********	**********	61.887	42.426

****** = NO DATA

TABLE B-45. ALUMINUM CONCENTRATIONS DETERMINED DURING 1977.

PARAMETER: ALUMINUM UNITS: MICROGRAMS/L

DATE	STATION NUMBER 1	2	3	4	5	6	7	8	9	10
JUNE 7, 1977	253.	328.	223.	328.	233.	******	********	233.	******	******
JUNE 21, 1977	*********	********	********	*********	******	******	********	*********	388.	******
AUG. 30, 1977	*********	********	********	*********	******	******	********	*********	60.	******
SEP. 13, 1977	< 50.	< 50.	< 50.	< 50.	< 50.	******	< 50.	< 50.	******	******
SEP. 27, 1977	90.	< 50.	< 50.	< 50.	< 50.	******	< 50.	< 50.	******	******
SEP. 28, 1977	*********	********	********	< 50.	******	******	********	*********	******	******
MAXIMUM	253.	328.	223.	328.	233.	**********	50.	233.	388.	**********
MINIMUM	50.	50.	50.	50.	50.	**********	50.	50.	60.	**********
MEAN	131.	143.	108.	120.	111.	**********	50.	111.	224.	**********
VARIANCE	11563.000	25761.333	9976.333	19321.000	11163.000	**********	0.000	11163.000	53792.000	**********
STD. DEV.	107.531	160.503	99.882	139.000	105.655	**********	0.000	105.655	231.931	**********

****** = NO DATA

TABLE B-46. CADMIUM CONCENTRATIONS DETERMINED DURING 1976.

PARAMETER: CADMIUM UNITS: MICROGRAMS/L

DATE	STATION NUMBER 1	2	3	4	5	6	7	8	9	10
MAY 19, 1976	*******	******	******	*******	0.7	0.5	*******	********	*****	*****
MAY 22, 1976	*******	******	******	*******	*****	*****	*******	********	0.3	0.3
MAY 29, 1976	*******	******	******	*******	0.2	0.4	*******	********	0.1	0.2
JUNE 23, 1976	*******	******	******	*******	0.4	0.2	*******	********	0.2	*****
JULY 1, 1976	0.2	0.2	0.2	0.4	0.3	0.5	*******	0.4	0.2	*****
JULY 7, 1976	0.1	0.1	0.1	0.1	*****	*****	*******	********	*****	*****
JULY 8, 1976	*******	******	******	*******	0.1	0.1	*******	********	0.1	*****
MAXIMUM	0.2	0.2	0.2	0.4	0.7	0.5	**********	0.4	0.3	0.3
MINIMUM	0.1	0.1	0.1	0.1	0.1	0.1	**********	0.4	0.1	0.2
MEAN	0.2	0.2	0.2	0.3	0.3	0.3	**********	0.4	0.2	0.3
VARIANCE	0.0050000	0.0050000	0.0050000	0.0450000	0.0530000	0.0330000	**********	**********	0.0070000	0.0050000
STD. DEV.	0.0707107	0.0707107	0.0707107	0.2121320	0.2302173	0.1816590	**********	**********	0.0836660	0.0707107

****** = NO DATA

TABLE B-47. CADMIUM CONCENTRATIONS DETERMINED DURING 1977

PARAMETER: CADMIUM UNITS: MICROGRAMS/L

DATE	STATION NUMBER 1	2	3	4	5	6	7	8	9	10
JUNE 7, 1977	5.0	6.0	6.0	7.0	4.0	*****	******	4.0	*****	*****
JUNE 21, 1977	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	*****	******	< 5.0	< 5.0	*****
JULY 5, 1977	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	*****	******	< 5.0	< 5.0	*****
JULY 19, 1977	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	*****	******	< 5.0	< 5.0	*****
AUG. 2, 1977	4.0	3.0	2.0	3.0	3.0	*****	******	3.0	3.0	*****
AUG. 16, 1977	2.0	4.0	3.0	3.0	4.0	*****	******	4.0	3.0	*****
AUG. 30, 1977	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	*****	******	< 5.0	< 5.0	*****
SEP. 13, 1977	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	*****	< 5.0	< 5.0	*****	*****
SEP. 27, 1977	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	*****	< 5.0	< 5.0	*****	*****
SEP. 28, 1977	*******	*******	******	< 5.0	*****	*****	******	*******	*****	*****
MAXIMUM	5.0	6.0	6.0	7.0	5.0	**********	5.0	5.0	5.0	**********
MINIMUM	2.0	3.0	2.0	3.0	3.0	**********	5.0	3.0	3.0	**********
MEAN	< 4.6	4.8	< 4.6	4.8	< 4.6	**********	5.0	4.6	4.3	**********
VARIANCE	1.0277778	0.6944444	1.5277778	1.2888889	0.5277778	**********	0.0000000	0.5277778	1.0666667	**********
STD. DEV.	1.0137938	0.8333333	1.2360331	1.1352924	0.7264832	**********	0.0000000	0.7264832	1.0327956	**********

****** = NO DATA

TABLE B-48. CHROMIUM CONCENTRATIONS DETERMINED DURING 1976

PARAMETER: CHROMIUM UNITS: MICROGRAMS/L

DATE	STATION NUMBER 1	2	3	4	5	6	7	8	9	10
MAY 19, 1976	********	*******	*******	********	9.	3.	*******	********	******	******
MAY 22, 1976	********	*******	*******	********	******	******	*******	********	1.	< 1.
MAY 29, 1976	********	*******	*******	********	2.	4.	*******	********	3.	3.
JUNE 23, 1976	********	*******	*******	********	57.	30.	*******	********	16.	******
JULY 1, 1976	6.	6.	4.	10.	20.	18.	*******	6.	3.	******
JULY 7, 1976	65.	50.	4.	2.	******	******	*******	********	******	******
JULY 8, 1976	********	*******	*******	********	22.	4.	*******	********	4.	******
MAXIMUM	65.	50.	4.	10.	57.	30.	*********	6.	16.	3.
MINIMUM	6.	6.	4.	2.	2.	3.	*********	6.	1.	1.
MEAN	36.	28.	4.	6.	22.	12.	*********	6.	5.	2.
VARIANCE	1740.5000	968.0000	0.0000	32.0000	449.5000	142.2000	*********	*********	36.3000	2.0000
STD. DEV.	41.7193	31.1127	0.0000	5.6569	21.2014	11.9248	*********	*********	6.0249	1.4142

****** = NO DATA

TABLE B-49. CHROMIUM CONCENTRATIONS DETERMINED DURING 1977

PARAMETER: CHROMIUM

UNITS: MICROGRAMS/L

DATE	STATION NUMBER 1	2	3	4	5	6	7	8	9	10
JUNE 7, 1977	< 10.	< 10.	< 10.	< 10.	< 10.	******	*******	< 10.	******	******
JUNE 21, 1977	< 10.	< 10.	< 10.	< 10.	< 10.	******	*******	< 10.	< 10.	******
JULY 5, 1977	< 10.	< 10.	< 10.	< 10.	< 10.	******	*******	< 10.	< 10.	******
JULY 19, 1977	< 10.	< 10.	< 10.	< 10.	< 10.	******	*******	< 10.	< 10.	******
AUG. 2, 1977	< 10.	< 10.	< 10.	< 10.	< 10.	******	*******	< 10.	< 10.	******
AUG. 16, 1977	< 10.	< 10.	< 10.	< 10.	< 10.	******	*******	< 10.	< 10.	******
AUG. 30, 1977	< 17.	< 17.	< 17.	< 17.	< 17.	******	*******	< 17.	< 17.	******
SEP. 13, 1977	< 17.	< 17.	< 17.	< 17.	< 17.	******	< 17.	< 17.	******	******
SEP. 27, 1977	< 17.	< 17.	< 17.	20.	< 17.	******	< 17.	< 17.	******	******
SEP. 28, 1977	*******	*******	*******	< 17.	******	******	*******	*******	******	******
MAXIMUM	17.	17.	17.	20.	17.	*********	17.	17.	17.	*********
MINIMUM	10.	10.	10.	10.	10.	*********	17.	10.	10.	*********
MEAN	12.	12.	12.	13.	12.	*********	17.	12.	11.	*********
VARIANCE	12.2500	12.2500	12.2500	16.7667	12.2500	*********	0.0000	12.2500	8.1667	*********
STD. DEV.	3.5000	3.5000	3.5000	4.0947	3.5000	*********	0.0000	3.5000	2.8577	*********

****** = NO DATA

TABLE B-50. COPPER CONCENTRATIONS DETERMINED DURING 1976

PARAMETER: COPPER

UNITS: MICROGRAMS/L

DATE	STATION NUMBER 1	2	3	4	5	6	7	8	9	10
MAY 19, 1976	*******	******	******	*******	20.0	13.0	******	*******	*****	*****
MAY 22, 1976	*******	******	******	*******	*****	*****	******	*******	2.0	3.0
MAY 29, 1976	*******	******	******	*******	12.0	10.0	******	*******	6.0	8.0
JUNE 23, 1976	*******	******	******	*******	16.0	9.0	******	*******	4.0	*****
JULY 1, 1976	31.0	17.0	10.0	10.0	9.0	14.0	******	8.2	8.0	*****
JULY 7, 1976	16.0	25.0	9.0	8.0	*****	*****	******	*******	*****	*****
JULY 8, 1976	*******	******	******	*******	12.0	9.0	******	*******	4.0	*****
MAXIMUM	31.0	25.0	10.0	10.0	20.0	14.0	*********	8.2	8.0	8.0
MINIMUM	16.0	17.0	9.0	8.0	9.0	9.0	*********	8.2	2.0	3.0
MEAN	23.5	21.0	9.5	9.0	13.8	11.0	*********	8.2	4.8	5.5
VARIANCE	112.5000	32.0000	0.5000	2.0000	18.2000	5.5000	*********	*********	5.2000	12.5000
STD. DEV.	10.6066	5.6569	0.7071	1.4142	4.2661	2.3452	*********	*********	2.2804	3.5355

****** = NO DATA

TABLE B-51. COPPER CONCENTRATIONS DETERMINED DURING 1977

PARAMETER: COPPER

UNITS: MICROGRAMS/L

DATE	STATION NUMBER									
	1	2	3	4	5	6	7	8	9	10
JUNE 7, 1977	41.0	27.0	21.0	21.0	21.0	******	*******	21.0	******	******
JUNE 21, 1977	162.0	27.0	27.0	20.0	240.0	******	*******	240.0	20.0	******
JULY 5, 1977	33.0	20.0	< 20.0	20.0	20.0	******	*******	20.0	< 20.0	******
JULY 19, 1977	50.0	15.0	5.0	13.0	20.0	******	*******	20.0	5.0	******
AUG. 2, 1977	20.0	20.0	10.0	5.0	40.0	******	*******	40.0	12.0	******
AUG. 16, 1977	24.0	14.0	18.0	13.0	13.0	******	*******	13.0	< 8.0	******
AUG. 30, 1977	11.0	8.0	10.0	< 8.0	9.0	******	*******	9.0	< 8.0	******
SEP. 13, 1977	22.0	12.0	11.0	< 8.0	< 8.0	******	*******	< 8.0	******	******
SEP. 27, 1977	10.0	10.0	16.0	10.0	10.0	******	< 8.0	10.0	******	******
MAXIMUM	162.0	27.0	27.0	21.0	240.0	**********	8.0	240.0	20.0	**********
MINIMUM	10.0	8.0	5.0	5.0	8.0	**********	8.0	8.0	5.0	**********
MEAN	41.4	17.0	< 15.3	13.1	42.3	**********	8.0	42.3	< 12.2	**********
VARIANCE	2217.0278	48.2500	47.5000	35.6111	5590.7500	**********	**********	5590.7500	41.7667	**********
STD. DEV.	47.0853	6.9462	6.8920	5.9675	74.7713	**********	**********	74.7713	6.4627	**********

****** = NO DATA

TABLE B-52. IRON CONCENTRATIONS DETERMINED DURING 1976

PARAMETER: IRON

UNITS: MICROGRAMS/L

DATE	STATION NUMBER 1	2	3	4	5	6	7	8	9	10
MAY 19, 1976	*********	********	********	*********	162.	56.	********	*********	******	******
MAY 22, 1976	*********	********	********	*********	******	******	********	*********	28.	61.
MAY 29, 1976	*********	********	********	*********	54.	31.	********	*********	3.	71.
JUNE 23, 1976	*********	********	********	*********	17.	8.	********	*********	4.	******
JULY 1, 1976	21.	35.	41.	35.	36.	33.	********	40.	68.	******
JULY 7, 1976	42.	25.	41.	16.	******	******	********	*********	******	******
JULY 8, 1976	*********	********	********	*********	11.	12.	********	*********	13.	******
MAXIMUM	42.	35.	41.	35.	162.	56.	**********	40.	68.	71.
MINIMUM	21.	25.	41.	16.	11.	8.	**********	40.	3.	61.
MEAN	32.	30.	41.	26.	56.	28.	**********	40.	23.	66.
VARIANCE	220.50	50.00	0.00	180.50	3796.50	368.50	**********	**********	727.70	50.00
STD. DEV.	14.85	7.07	0.00	13.44	61.62	19.20	**********	**********	26.98	7.07

****** = NO DATA

TABLE B-53. IRON CONCENTRATIONS DETERMINED DURING 1977

PARAMETER: IRON

UNITS: MICROGRAMS/L

DATE	STATION NUMBER 1	2	3	4	5	6	7	8	9	10
JUNE 7, 1977	45.	61.	84.	126.	45.	******	*******	45.	******	******
JUNE 21, 977	986.	624.	607.	804.	1249.	******	*******	1249.	446.	******
JULY 5, 1977	233.	181.	222.	168.	190.	******	*******	190.	233.	******
JULY 19, 1977	71.	51.	65.	187.	36.	******	*******	36.	229.	******
AUG. 30, 1977	21.	19.	23.	15.	< 13.	******	*******	< 13.	< 13.	******
SEP. 13, 1977	19.	23.	14.	189.	14.	******	278.	14.	******	******
SEP. 27, 1977	25.	19.	24.	17.	19.	******	27.	19.	******	******
SEP. 28, 1977	********	*******	*******	< 13.	******	******	*******	********	******	******
MAXIMUM	986.	624.	607.	804.	1249.	**********	278.	1249.	446.	**********
MINIMUM	19.	19.	14.	13.	13.	**********	27.	13.	13.	**********
MEAN	200.	140.	148.	190.	224.	**********	153.	224.	230.	**********
VARIANCE	125829.67	48844.90	46016.29	67638.41	208301.90	**********	31500.50	208301.90	31251.58	**********
STD. DEV.	354.72	221.01	214.51	260.07	456.40	**********	177.48	456.40	176.78	**********

****** = NO DATA

TABLE B-54. LEAD CONCENTRATIONS DETERMINED DURING 1976

PARAMETER: LEAD UNITS: MICROGRAMS/

DATE	STATION NUMBER 1	2	3	4	5	6	7	8	9	10
MAY 19, 1976	********	*******	*******	*******	4.0	3.0	*******	********	******	******
MAY 22, 1976	********	*******	*******	*******	******	******	*******	********	4.0	4.0
MAY 29, 1976	********	*******	*******	*******	3.0	3.0	*******	********	3.0	3.0
JUNE 23, 1976	********	*******	*******	*******	3.0	3.0	*******	********	2.0	******
JULY 1, 1976	3.0	3.0	3.0	3.0	3.0	3.0	*******	3.0	2.0	******
JULY 7, 1976	4.0	2.0	3.0	3.0	******	******	*******	********	******	******
JULY 8, 1976	********	*******	*******	*******	3.0	3.0	*******	********	3.0	******
MAXIMUM	4.0	3.0	3.0	3.0	4.0	3.0	**********	3.0	4.0	4.0
MINIMUM	3.0	2.0	3.0	3.0	3.0	3.0	**********	3.0	2.0	3.0
MEAN	3.5	2.5	3.0	3.0	3.2	3.0	**********	3.0	2.8	3.5
VARIANCE	0.5000000	0.5000000	0.0000000	0.0000000	0.2000000	0.0000000	**********	**********	0.7000000	0.5000000
STD. DEV.	0.7071068	0.7071068	0.0000000	0.0000000	0.4472136	0.0000000	**********	**********	0.8366600	0.7071068

****** = NO DATA

TABLE B-55. LEAD CONCENTRATIONS DETERMINED DURING 1977

PARAMETER: LEAD

UNITS: MICROGRAMS/L

DATE	STATION NUMBER 1	2	3	4	5	6	7	8	9	10
JUNE 7, 1977	*******	< 0.9	< 0.9	< 0.9	< 0.9	*****	******	< 0.9	*****	*****
JUNE 21, 1977	< 0.9	< 0.9	< 0.9	< 0.9	< 0.9	*****	******	< 0.9	< 0.9	*****
JULY 5, 1977	< 0.9	< 0.9	< 0.9	8.0	< 0.9	*****	******	< 0.9	< 0.9	*****
JULY 19, 1977	< 0.9	< 0.9	< 0.9	< 0.9	< 0.9	*****	******	< 0.9	< 0.9	*****
AUG. 2, 1977	< 0.9	< 0.9	< 0.9	< 0.9	< 0.9	*****	******	< 0.9	< 0.9	*****
AUG. 16, 1977	< 0.9	< 0.9	< 0.9	< 0.9	< 0.9	*****	******	< 0.9	< 0.9	*****
AUG. 30, 1977	< 0.9	< 0.9	< 0.9	< 0.9	< 0.9	*****	******	< 0.9	*****	*****
SEP. 13, 1977	< 0.9	< 0.9	< 0.9	< 0.9	< 0.9	*****	< 0.9	< 0.9	*****	*****
SEP. 27, 1977	< 0.9	< 0.9	< 0.9	< 0.9	< 0.9	*****	< 0.9	< 0.9	*****	*****
SEP. 28, 1977	*******	******	******	< 0.9	*****	*****	******	*******	*****	*****
MAXIMUM	0.9	0.9	0.9	8.0	0.9	**********	0.9	0.9	0.9	**********
MINIMUM	0.9	0.9	0.9	0.9	0.9	**********	0.9	0.9	0.9	**********
MEAN	0.9	0.9	0.9	1.6	0.9	**********	0.9	0.9	0.9	**********
VARIANCE	0.0000000	0.0000000	0.0000000	5.0410000	0.0000000	**********	0.0000000	0.0000000	0.0000000	**********
STD. DEV.	0.0000025	0.0000023	0.0000023	2.2452171	0.0000023	**********	0.0000000	0.0000023	0.0000019	**********

****** = NO DATA

TABLE B-56. MAGNESIUM CONCENTRATIONS DETERMINED DURING 1976

PARAMETER: MAGNESIUM

UNITS: MG/L

DATE	STATION NUMBER 1	2	3	4	5	6	7	8	9	10
MAY 19, 1976	*********	********	*******	*********	10.4	4.9	********	*********	******	******
MAY 22, 1976	*********	********	*******	*********	********	********	********	*********	13.0	11.5
MAY 29, 1976	*********	********	*******	*********	17.1	23.0	********	*********	3.9	14.9
JUNE 23, 1976	*********	********	*******	*********	18.6	14.5	********	*********	16.6	******
JULY 1, 1976	16.8	21.5	13.6	18.7	11.9	22.9	********	13.6	16.8	******
JULY 7, 1976	8.1	6.7	5.5	8.5	********	********	********	*********	******	******
JULY 8, 1976	*********	********	*******	*********	8.6	6.0	********	*********	7.2	******
JULY 13, 1976	8.3	8.4	6.4	6.5	********	********	********	*********	******	******
JULY 14, 1976	*********	********	*******	0.0	********	********	0.4	10.8	******	******
JULY 15, 1976	*********	********	*******	*********	7.2	3.3	********	3.3	6.2	******
JULY 22, 1976	4.8	2.9	1.3	5.6	0.3	2.8	8.6	10.8	11.0	******
JULY 29, 1976	9.5	13.2	7.9	1.9	6.6	6.3	2.1	0.2	14.5	******
AUG. 5, 1976	8.8	18.1	4.9	6.6	18.3	13.1	********	14.3	10.4	******
AUG. 12, 1976	16.3	16.2	12.2	10.7	4.2	19.0	********	15.0	11.9	******
AUG. 20, 1976	6.2	7.4	7.4	11.8	10.4	6.7	********	0.0	13.2	******
AUG. 27, 1976	20.3	17.2	6.5	4.7	********	********	********	7.2	15.3	******
SEP. 2, 1976	7.3	11.2	2.7	7.4	7.2	12.8	********	10.1	7.2	******
SEP. 10, 1976	14.3	11.0	6.6	6.0	********	********	********	7.3	13.5	******
SEP. 17, 1976	8.2	16.1	8.5	15.2	********	********	********	3.5	14.1	******
SEP. 24, 1976	11.6	10.9	12.6	12.3	********	********	********	5.0	13.7	******
OCT. 1, 1976	4.2	6.9	9.1	11.6	********	********	********	*********	******	******
OCT. 8, 1976	4.8	11.1	3.4	6.2	********	********	********	*********	******	******
OCT. 15, 1976	4.5	6.3	5.5	5.0	********	********	********	*********	******	******
OCT. 22, 1976	10.9	9.8	3.3	7.8	********	********	********	*********	******	******
MAXIMUM	20.3	21.5	13.6	18.7	18.6	23.0	8.6	15.0	16.8	14.9
MINIMUM	4.2	2.9	1.3	0.0	0.3	2.8	0.4	0.0	3.9	11.5
MEAN	9.7	11.5	6.9	8.1	10.1	11.3	3.7	7.8	11.8	13.2
VARIANCE	22.717500	24.846176	12.296838	21.066046	32.187879	54.356591	18.730000	26.400256	14.764292	5.780000
STD. DEV.	4.766288	4.984594	3.506685	4.589776	5.673436	7.372692	4.327817	5.138118	3.842433	2.404163

****** = NO DATA

TABLE B-57. MAGNESIUM CONCENTRATIONS DETERMINED DURING 1977

PARAMETER: MAGNESIUM UNITS: MG/L

DATE	STATION NUMBER 1	2	3	4	5	6	7	8	9	10
JUNE 7, 1977	********	27.8	27.7	27.8	26.5	********	********	26.5	******	******
AUG. 30, 1977	********	********	********	********	********	********	********	********	22.1	******
SEP. 13, 1977	24.6	25.2	25.3	27.2	25.2	********	27.6	25.2	******	******
SEP. 27, 1977	22.9	23.5	23.7	24.2	23.9	********	24.9	23.9	******	******
MAXIMUM	24.6	27.8	27.7	27.8	26.5	**********	27.6	26.5	22.1	**********
MINIMUM	22.9	23.5	23.7	24.2	23.9	**********	24.9	23.9	22.1	**********
MEAN	23.8	25.5	25.6	26.4	25.2	**********	26.3	25.2	22.1	**********
VARIANCE	1.445000	4.690000	4.053333	3.720000	1.690000	**********	3.645000	1.690000	**********	**********
STD. DEV.	1.202082	2.165641	2.013289	1.928730	1.300000	**********	1.909188	1.300000	**********	**********

****** = NO DATA

TABLE B-58. MANGANESE CONCENTRATIONS DETERMINED DURING 1976

PARAMETER: MANGANESE

UNITS: MICROGRAMS/L

DATE	STATION NUMBER									
	1	2	3	4	5	6	7	8	9	10
MAY 19, 1976	********	*******	*******	********	33.	4.	*******	********	******	******
MAY 22, 1976	********	*******	*******	********	******	******	*******	********	6.	5.
MAY 29, 1976	********	*******	*******	********	16.	8.	*******	********	7.	10.
JUNE 23, 1976	********	*******	*******	********	31.	35.	*******	********	9.	******
JULY 1, 1976	11.	13.	25.	24.	18.	23.	*******	********	33.	******
JULY 7, 1976	11.	7.	6.	5.	******	******	*******	********	******	******
JULY 8, 1976	********	*******	*******	********	7.	7.	*******	********	7.	******
MAXIMUM	11.	13.	25.	24.	33.	35.	*********	*********	33.	10.
MINIMUM	11.	7.	6.	5.	7.	4.	*********	*********	6.	5.
MEAN	11.	10.	16.	15.	21.	15.	*********	*********	12.	8.
VARIANCE	0.00000	18.00000	180.50000	180.50000	118.50000	174.30000	*********	*********	141.00000	12.50000
STD. DEV.	0.00000	4.24264	13.43503	13.43503	10.88577	13.20227	*********	*********	11.87434	3.53553

****** = NO DATA

TABLE B-59. MANGANESE CONCENTRATIONS DETERMINED DURING 1977

PARAMETER: MANGANESE UNITS: MICROGRAMS/L

DATE	STATION NUMBER 1	2	3	4	5	6	7	8	9	10
JUNE 7, 1977	5.	23.	6.	45.	20.	******	*******	20.	******	******
JUNE 21, 1977	< 5.	12.	8.	< 5.	8.	******	*******	8.	7.	******
JULY 5, 1977	6.	< 5.	< 5.	6.	6.	******	*******	6.	5.	******
JULY 19, 1977	8.	< 5.	12.	< 5.	8.	******	*******	8.	< 5.	******
AUG. 30, 1977	********	*******	*******	********	******	******	*******	********	6.	******
SEP. 13, 1977	7.	13.	7.	16.	8.	******	57.	8.	******	******
SEP. 27, 1977	8.	15.	14.	5.	8.	******	29.	8.	******	******
SEP. 28, 1977	********	*******	*******	20.	******	******	*******	********	******	******
MAXIMUM	8.	23.	14.	45.	20.	**********	57.	20.	7.	**********
MINIMUM	5.	5.	5.	5.	6.	**********	29.	6.	5.	**********
MEAN	7.	12.	9.	15.	10.	**********	43.	10.	6.	**********
VARIANCE	1.90000	45.76667	12.66667	217.61905	26.26667	**********	392,00000	26.26667	0.91667	**********
STD. DEV.	1.37840	6.76511	3.55903	14.75192	5.12510	**********	19,79899	5.12510	0.95743	**********

****** = NO DATA

TABLE B-60. MERCURY CONCENTRATIONS DETERMINED DURING 1976

PARAMETER: MERCURY

UNITS: MICROGRAMS/L

DATE	STATION NUMBER 1	2	3	4	5	6	7	8	9	10
MAY 19, 1976	********	******	******	********	3.3	5.0	******	********	*****	*****
MAY 22, 1976	********	******	******	********	*****	*****	******	********	2.7	4.5
MAY 29, 1976	********	******	******	********	1.2	2.1	******	********	1.6	2.6
JUNE 23, 1976	********	******	******	********	3.2	2.9	******	********	2.0	*****
JULY 1, 1976	2.4	0.6	2.7	1.5	2.9	2.4	******	2.7	3.4	*****
JULY 7, 1976	1.5	0.0	1.5	1.5	*****	*****	******	********	*****	*****
JULY 8, 1976	********	******	******	********	2.3	1.6	******	********	3.0	*****
JULY 13, 1976	4.1	4.5	7.6	6.1	*****	*****	******	********	*****	*****
JULY 15, 1976	********	******	******	********	3.5	4.7	******	********	7.3	*****
JULY 22, 1976	27.0	15.2	14.1	********	50.0	15.1	******	21.0	19.7	*****
JULY 29, 1976	16.9	6.0	3.3	4.9	4.4	6.6	3.8	14.3	9.7	*****
SEP. 2, 1976	3.6	4.2	1.8	4.7	4.0	5.4	******	10.5	17.8	*****
SEP. 10, 1976	3.0	12.7	2.7	3.3	*****	*****	******	3.3	2.8	*****
SEP. 17, 1976	2.3	8.2	1.4	5.2	*****	*****	******	2.1	3.5	*****
SEP. 24, 1976	11.5	6.0	2.8	3.2	*****	*****	******	3.1	4.1	*****
MAXIMUM	27.0	15.2	14.1	6.1	50.0	15.1	3.8	21.0	19.7	4.5
MINIMUM	1.5	0.0	1.4	1.5	1.2	1.6	3.8	2.1	1.6	2.6
MEAN	8.0	6.4	4.2	3.8	8.3	5.1	3.8	8.1	6.5	3.6
VARIANCE	77.26500	25.46694	17.21611	2.92286	245.27611	16.98611	*********	53.96619	38.34606	1.80500
STD. DEV.	8.79005	5.04648	4.14923	1.70964	15.66129	4.12142	*********	7.34617	6.19242	1.34350

****** = NO DATA

TABLE B-61. MERCURY CONCENTRATIONS DETERMINED DURING 1977

PARAMETER: MERCURY

UNITS: MICROGRAMS/L

DATE	STATION NUMBER 1	2	3	4	5	6	7	8	9	10
JUNE 7, 1977	0.8	0.3	0.7	2.1	1.4	*****	******	1.4	*****	*****
JUNE 21, 1977	1.7	< 0.2	< 0.2	0.5	0.6	*****	******	0.6	23.0	*****
JULY 5, 1977	< 0.2	< 0.2	5.9	< 0.2	< 0.2	*****	******	< 0.2	< 0.2	*****
JULY 19, 1977	0.7	0.7	0.8	0.6	5.9	*****	******	5.9	0.4	*****
AUG. 2, 1977	1.3	1.6	0.9	0.9	0.4	*****	******	0.4	2.0	*****
AUG. 16, 1977	4.5	3.4	0.8	1.4	3.8	*****	******	3.8	1.6	*****
AUG. 30, 1977	0.4	0.4	2.0	0.4	0.2	*****	******	0.2	0.4	*****
SEP. 13, 1977	4.0	0.4	0.4	0.5	0.7	*****	< 0.2	0.7	*****	*****
SEP. 27, 1977	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	*****	< 0.2	< 0.2	*****	*****
SEP. 28, 1977	*******	******	******	< 0.2	*****	*****	******	*******	*****	*****
MAXIMUM	4.5	3.4	5.9	2.1	5.9	**********	0.2	5.9	23.0	**********
MINIMUM	0.2	0.2	0.2	0.2	0.2	**********	0.2	0.2	0.2	**********
MEAN	< 1.5	< 0.8	< 1.3	0.7	1.5	**********	0.2	1.5	4.6	**********
VARIANCE	2.63000	1.13194	3.23694	0.38000	4.04861	**********	0.00000	4.04861	81.79200	**********
STD. DEV.	1.62173	1.06393	1.79915	0.61644	2.01212	**********	0.00000	2.01212	9.04389	**********

****** = NO DATA

TABLE B-62. POTASSIUM CONCENTRATIONS DETERMINED DURING 1976

PARAMETER: POTASSIUM UNITS: MG/L

DATE	STATION NUMBER 1	2	3	4	5	6	7	8	9	10
MAY 19, 1976	********	*******	*******	********	10.0	11.3	*******	********	******	******
MAY 22, 1976	********	*******	*******	********	*******	*******	*******	********	1.2	2.2
MAY 29, 1976	********	*******	*******	********	13.1	9.9	*******	********	1.1	4.4
JUNE 23, 1976	********	*******	*******	********	11.2	12.3	*******	********	1.0	******
JULY 1, 1976	9.6	10.3	10.8	10.9	10.8	13.1	*******	10.2	0.9	******
JULY 7, 1976	9.0	10.2	9.4	9.8	*******	*******	*******	********	******	******
JULY 8, 1976	********	*******	*******	********	9.8	11.5	*******	********	0.9	******
JULY 13, 1976	9.7	10.6	11.9	10.9	*******	*******	*******	********	******	******
JULY 14, 1976	********	*******	*******	11.7	*******	*******	14.7	11.0	******	******
JULY 15, 1976	********	*******	*******	********	11.0	11.7	*******	10.0	1.1	******
JULY 22, 1976	9.8	9.2	8.8	10.0	9.9	10.8	12.2	10.5	0.7	******
JULY 29, 1976	8.6	7.9	7.9	8.8	8.4	9.1	8.8	8.4	0.7	******
AUG. 5, 1976	9.8	10.3	10.9	11.2	10.7	10.9	*******	10.7	1.0	******
AUG. 12, 1976	10.3	10.2	10.0	10.2	10.0	10.5	*******	9.7	1.0	******
AUG. 20, 1976	10.9	10.0	10.3	10.9	10.6	11.1	*******	10.3	1.1	******
AUG. 27, 1976	9.9	9.7	10.2	10.0	*******	*******	*******	10.4	1.2	******
SEP. 2, 1976	10.7	11.6	10.2	11.4	10.8	11.4	*******	13.5	1.2	******
SEP. 10, 1976	9.4	11.1	11.3	9.2	*******	*******	*******	10.5	1.3	******
OCT. 1, 1976	10.8	11.8	9.9	12.2	*******	*******	*******	********	******	******
OCT. 22, 1976	11.1	10.0	11.1	10.9	*******	*******	*******	********	******	******
MAXIMUM	11.1	11.8	11.9	12.2	13.1	13.1	14.7	13.5	1.3	4.4
MINIMUM	8.6	7.9	7.9	8.8	8.4	9.1	8.8	8.4	0.7	2.2
MEAN	10.0	10.2	10.2	10.6	10.5	11.1	11.9	10.5	1.0	3.3
VARIANCE	0.573974	1.010256	1.1491[illegible]	0.911044	1.225682	1.091515	8.770000	1.472182	0.032967	2.420000
STD. DEV.	0.757611	1.005115	1.071962	0.954486	1.107105	1.044756	2.961419	1.213335	0.181568	1.555635

****** = NO DATA

TABLE B-63. POTASSIUM CONCENTRATIONS DETERMINED DURING 1977

PARAMETER: POTASSIUM UNITS: MG/L

DATE	STATION NUMBER 1	2	3	4	5	6	7	8	9	10
JUNE 7, 1977	12.8	13.2	13.3	14.4	13.4	********	********	13.4	******	******
JUNE 21, 1977	12.4	12.5	12.8	13.1	13.1	********	********	13.1	2.1	******
JULY 5, 1977	13.7	13.2	12.8	13.3	13.4	********	********	13.4	2.0	******
JULY 19, 1977	12.2	10.6	11.8	9.9	11.2	********	********	11.2	1.8	******
AUG. 2, 1977	1.7	11.5	11.7	11.7	11.9	********	********	11.9	1.9	******
AUG. 16, 1977	11.4	11.6	11.6	11.5	11.5	********	********	11.5	1.8	******
AUG. 30, 1977	********	********	********	*********	********	********	********	*********	2.4	******
SEP. 13, 1977	13.2	13.1	12.7	13.8	12.9	********	21.8	12.9	******	******
SEP. 27, 1977	12.5	12.6	12.4	12.8	12.5	********	15.5	12.5	******	******
SEP. 28, 1977	*********	********	********	12.6	********	********	********	*********	******	******
MAXIMUM	13.7	13.2	13.3	14.4	13.4	**********	21.8	13.4	2.4	**********
MINIMUM	11.4	10.6	11.6	9.9	11.2	**********	15.5	11.2	1.8	**********
MEAN	12.5	12.3	12.4	12.6	12.5	**********	18.7	12.5	2.0	**********
VARIANCE	0.566964	0.915536	0.386964	1.845000	0.741250	**********	19.845000	0.741250	0.052000	**********
STD. DEV.	0.752970	0.956836	0.622065	1.358308	0.860959	**********	4.454773	0.860959	0.228035	**********

****** = NO DATA

TABLE B-64. SILVER CONCENTRATIONS DETERMINED DURING 1976

PARAMETER: SILVER

UNITS: MICROGRAMS/L

DATE	STATION NUMBER 1	2	3	4	5	6	7	8	9	10
MAY 19, 1976	********	******	******	*******	< 1.0	< 1.0	******	*******	*****	*****
MAY 22, 1976	********	******	******	*******	*****	*****	******	*******	< 1.0	< 1.0
MAY 29, 1976	********	******	******	*******	< 1.0	< 1.0	******	*******	< 1.0	< 1.0
JUNE 23, 1976	********	******	******	*******	1.7	1.1	******	*******	< 1.0	*****
JULY 1, 1976	< 1.0	4.9	1.1	< 1.0	1.1	< 1.0	******	< 1.0	1.1	*****
JULY 7, 1976	1.2	3.4	1.1	< 1.0	*****	*****	******	*******	*****	*****
JULY 8, 1976	********	******	******	*******	< 1.0	< 1.0	******	*******	< 1.0	*****
MAXIMUM	1.2	4.9	1.1	1.0	1.7	1.1	**********	1.	1.1	1.0
MINIMUM	1.0	3.4	1.1	1.0	1.0	1.0	**********	1.0	1.0	1.0
MEAN	1.1	4.2	1.1	1.0	1.2	1.0	**********	1.0	1.0	1.0
VARIANCE	0.0200000	1.1250000	0.0000000	0.0000000	0.0930000	0.0020000	**********	**********	0.0020000	0.0000000
STD. DEV.	0.1414214	1.0606602	0.0000000	0.0000000	0.3049590	0.0447214	**********	**********	0.0447214	0.0000000

****** = NO DATA

TABLE B-65. SILVER CONCENTRATIONS DETERMINED DURING 1977

PARAMETER: SILVER UNITS: MICROGRAMS/L

DATE	STATION NUMBER 1	2	3	4	5	6	7	8	9	10
JUNE 7, 1977	********	< 5.0	< 5.0	< 5.0	< 5.0	*****	******	< 5.0	*****	*****
JUNE 21, 1977	********	******	******	*******	*****	*****	******	*******	< 5.0	*****
AUG. 30, 1977	********	******	******	*******	*****	*****	******	*******	< 6.0	*****
SEP. 13, 1977	< 6.0	< 6.0	< 6.0	< 6.0	< 6.0	*****	< 6.0	< 6.0	*****	*****
SEP. 27, 1977	< 6.0	< 6.0	< 6.0	< 6.0	< 6.0	*****	< 6.0	< 6.0	*****	*****
SEP. 28, 1977	********	******	******	< 6.0	*****	*****	******	*******	*****	*****
MAXIMUM	6.0	6.0	6.0	6.0	6.0	**********	6.0	6.0	6.0	**********
MINIMUM	6.0	5.0	5.0	5.0	5.0	**********	6.0	5.0	5.0	**********
MEAN	6.0	5.7	5.7	5.8	5.7	**********	6.0	5.7	5.5	**********
VARIANCE	0.0000000	0.3333333	0.3333333	0.2500000	0.3333333	**********	0.0000000	0.3333333	0.5000000	**********
STD. DEV.	0.0000000	0.5773503	0.5773503	0.5000000	0.5773503	**********	0.0000000	0.5773503	0.7071068	**********

****** = NO DATA

TABLE B-66. SODIUM CONCENTRATIONS DETERMINED DURING 1976

PARAMETER: SODIUM　　UNITS: MG/L

DATE	STATION NUMBER 1	2	3	4	5	6	7	8	9	10
MAY 19, 1976	********	*******	*******	********	106.	106.	*******	********	******	******
MAY 22, 1976	********	*******	*******	********	******	******	*******	********	19.	19.
MAY 29, 1976	********	*******	*******	********	109.	109.	*******	********	17.	19.
JUNE 23, 1976	********	*******	*******	********	106.	104.	*******	********	17.	******
JULY 1, 1976	88.	106.	98.	97.	102.	97.	*******	99.	17.	******
JULY 7, 1976	117.	113.	117.	113.	******	******	*******	********	******	******
JULY 8, 1976	********	*******	*******	********	109.	123.	*******	********	16.	******
JULY 13, 1976	102.	128.	114.	119.	******	******	*******	********	******	******
JULY 14, 1976	********	*******	*******	126.	******	******	119.	114.	******	******
JULY 15, 1976	********	*******	*******	********	119.	123.	*******	117.	18.	******
JULY 22, 1976	118.	111.	108.	117.	119.	138.	121.	114.	19.	******
JULY 29, 1976	149.	131.	134.	138.	134.	138.	138.	134.	19.	******
AUG. 5, 1976	137.	118.	156.	148.	140.	148.	*******	137.	19.	******
AUG. 12, 1976	119.	134.	123.	127.	119.	123.	*******	123.	19.	******
AUG. 20, 1976	115.	131.	115.	112.	119.	131.	*******	127.	19.	******
AUG. 27, 1976	109.	103.	107.	113.	******	******	*******	115.	20.	******
SEP. 2, 1976	120.	135.	120.	130.	133.	127.	*******	133.	20.	******
SEP. 10, 1976	115.	109.	113.	113.	******	******	*******	109.	19.	******
SEP. 17, 1976	98.	107.	107.	105.	******	******	*******	102.	17.	******
SEP. 24, 1976	113.	115.	115.	117.	******	******	*******	118.	20.	******
OCT. 1, 1976	138.	148.	150.	158.	******	******	*******	********	******	******
OCT. 8, 1976	95.	94.	82.	95.	******	******	*******	********	******	******
OCT. 22, 1976	129.	119.	123.	119.	******	******	*******	********	******	******
MAXIMUM	149.	148.	156.	158.	140.	148.	138.	137.	20.	19.
MINIMUM	88.	94.	82.	95.	102.	97.	119.	99.	16.	19.
MEAN	116.	119.	118.	120.	118.	122.	126.	119.	18.	19.
VARIANCE	267.71667	206.78333	324.91667	271.50735	152.26515	242.75000	109.00000	140.25641	1.59583	0.00000
STD. DEV.	16.36205	14.37996	18.02544	16.47748	12.33958	15.58044	10.44031	11.84299	1.26326	0.00000

****** = NO DATA

TABLE B-67. SODIUM CONCENTRATIONS DETERMINED DURING 1977

PARAMETER: SODIUM　　　UNITS: MG/L

DATE	STATION NUMBER 1	2	3	4	5	6	7	8	9	10
JUNE 7, 1977	130.	130.	124.	125.	129.	******	********	129.	******	******
JUNE 21, 1977	128.	132.	131.	128.	130.	******	********	130.	21.	******
JULY 5, 1977	124.	125.	124.	114.	115.	******	********	115.	17.	******
JULY 19, 1977	158.	144.	145.	145.	158.	******	********	158.	22.	******
AUG. 2, 1977	135.	136.	139.	138.	141.	******	********	141.	21.	******
AUG. 16, 1977	143.	142.	143.	140.	143.	******	********	143.	22.	******
AUG. 30, 1977	********	*******	*******	********	******	******	********	********	15.	******
SEP. 13, 1977	158.	159.	152.	168.	154.	******	142.	154.	******	******
SEP. 27, 1977	132.	138.	137.	138.	145.	******	140.	145.	******	******
SEP. 28, 1977	********	*******	*******	137.	******	******	********	********	******	******
MAXIMUM	158.	159.	152.	168.	158.	**********	142.	158.	22.	**********
MINIMUM	124.	125.	124.	114.	115.	**********	140.	115.	15.	**********
MEAN	139.	138.	138.	137.	139.	**********	141.	139.	20.	**********
VARIANCE	175.42857	109.35714	85.14286	223.75000	199.69643	**********	2.00000	199.69643	8.66667	**********
STD. DEV.	13.24495	10.45740	9.22729	14.95828	14.13140	**********	1.41421	14.13140	2.94392	**********

****** = NO DATA

TABLE B-68. ZINC CONCENTRATIONS DETERMINED DURING 1976

PARAMETER: ZINC

UNITS: MICROGRAMS/L

DATE	STATION NUMBER 1	2	3	4	5	6	7	8	9	10
JUNE 7, 1977	58.	36.	22.	25.	32.	******	*******	32.	******	******
JUNE 21, 1977	40.	42.	28.	14.	34.	******	*******	34.	19.	******
JULY 5, 1977	46.	21.	25.	12.	18.	******	*******	18.	15.	******
JULY 19, 1977	75.	35.	32.	24.	29.	******	*******	29.	13.	******
AUG. 2, 1977	40.	27.	24.	22.	37.	******	*******	37.	47.	******
AUG. 16, 1977	32.	23.	22.	18.	21.	******	*******	21.	12.	******
AUG. 30, 1977	32.	22.	21.	16.	24.	******	*******	24.	******	******
SEP. 13, 1977	36.	30.	27.	26.	26.	******	26.	26.	******	******
SEP. 27, 1977	39.	33.	32.	26.	34.	******	24.	34.	******	******
SEP. 28, 1977	********	*******	*******	20.	******	******	*******	********	******	******
MAXIMUM	75.	42.	32.	26.	37.	*********	26.	37.	47.	*********
MINIMUM	32.	21.	21.	12.	18.	*********	24.	18.	2.	*********
MEAN	44.	30.	26.	20.	28.	*********	25.	28.	21.	*********
VARIANCE	196.19444	52.11111	17.36111	26.23333	42.25000	*********	2.00000	42.25000	215.20000	*********
STD. DEV.	14.00694	7.21880	4.16667	5.12185	6.50000	*********	1.41421	6.50000	14.66970	*********

****** = NO DATA

TABLE B-69. ZINC CONCENTRATIONS DETERMINED DURING 1977

PARAMETER: ARSENIC

UNITS: MICROGRAMS/L

DATE	STATION NUMBER 1	2	3	4	5	6	7	8	9	10
JUNE 7, 1977	********	2.8	2.7	4.3	2.7	******	*******	2.7	******	******
JUNE 21, 1977	********	*******	*******	********	******	******	*******	********	23.7	******
JULY 5, 1977	********	*******	*******	********	******	******	*******	********	11.3	******
JULY 19, 1977	********	*******	*******	********	******	******	*******	********	12.8	******
AUG. 2, 1977	********	*******	*******	********	******	******	*******	********	25.3	******
SEP. 13, 1977	< 1.0	1.0	1.0	1.0	1.0	******	5.0	1.0	******	******
SEP. 19, 1977	********	*******	*******	********	******	******	*******	********	< 1.0	******
SEP. 27, 1977	1.0	< 1.0	< 1.0	1.0	1.0	******	2.0	1.0	******	******
SEP. 28, 1977	********	*******	*******	1.0	******	******	*******	********	******	******
MAXIMUM	1.0	2.8	2.7	4.3	2.7	**********	5.0	2.7	25.3	**********
MINIMUM	1.0	1.0	1.0	1.0	1.0	**********	2.0	1.0	1.0	**********
MEAN	1.0	1.6	1.6	1.8	1.6	**********	3.5	1.6	14.8	**********
VARIANCE	0.000000	1.080000	0.963333	2.722500	0.963333	**********	4.500000	0.963333	99.037000	**********
STD. DEV.	0.000000	1.039230	0.981495	1.650000	0.981495	**********	2.121320	0.981495	9.951734	**********

****** = NO DATA

TABLE B-70. ARSENIC CONCENTRATIONS DETERMINED DURING 1977

PARAMETER, ZINC

UNITS: MICROGRAMS/L

DATE	STATION NUMBER 1	2	3	4	5	6	7	8	9	10
MAY 19, 1976	********	*******	*******	********	58.	38.	*******	********	******	******
MAY 22, 1976	********	*******	*******	********	******	******	*******	********	10.	16.
MAY 29, 1976	********	*******	*******	********	10.	< 10.	*******	********	< 10.	< 10.
JUNE 23, 1976	********	*******	*******	********	< 10.	< 10.	*******	********	10.	******
JULY 1, 1976	< 10.	10.	< 10.	< 10.	< 10.	< 10.	*******	< 10.	0.	******
JULY 7, 1976	50.	35.	30.	30.	******	******	*******	********	******	******
JULY 8, 1976	********	*******	*******	********	30.	30.	*******	********	25.	******
JULY 13, 1976	40.	25.	20.	10.	******	******	*******	********	******	******
JULY 14, 1976	********	*******	*******	22.	******	******	20.	10.	******	******
MAXIMUM	50.	35.	30.	30.	58.	38.	20.	10.	25.	16.
MINIMUM	10.	10.	10.	10.	10.	10.	20.	10.	0.	10.
MEAN	< 33.	23.	< 20.	18.	24.	20.	20.	10.	11.	13.
VARIANCE	433.33333	158.33333	100.00000	96.00000	444.80000	180.80000	*********	0.00000	80.00000	18.00000
STD. DEV.	20.81666	12.58306	10.00000	9.79796	21.09028	13.44619	*********	0.00000	8.94427	4.24264

****** = NO DATA

TABLE B-71. NICKEL CONCENTRATIONS DETERMINED DURING 1977

PARAMETER: NICKEL UNITS: MICROGRAMS/

DATE	STATION NUMBER 1	2	3	4	5	6	7	8	9	10
JUNE 7, 1977	< 1.	6.	7.	6.	< 1.	******	*******	< 1.	******	******
JUNE 21, 1977	3.	6.	6.	5.	5.	******	*******	5.	3.	******
JULY 5, 1977	7.	4.	5.	3.	6.	******	*******	6.	1.	******
AUG. 30, 1977	********	*******	*******	********	******	******	*******	********	< 3.	******
SEP. 13, 1977	< 3.	< 3.	< 3.	< 3.	< 3.	******	< 3.	< 3.	******	******
SEP. 27, 1977	< 3.	< 3.	< 3.	< 3.	< 3.	******	< 3.	< 3.	******	******
SEP. 28, 1977	********	*******	*******	< 3.	******	******	*******	********	******	******
MAXIMUM	7.	6.	7.	6.	6.	**********	3.	6.	3.	**********
MINIMUM	1.	3.	3.	3.	1.	**********	3.	1.	1.	**********
MEAN	3.	4.	5.	4.	4.	**********	3.	4.	2.	**********
VARIANCE	4.8000000	2.3000000	3.2000000	1.7666667	3.8000000	**********	0.0000000	3.8000000	1.3333333	**********
STD. DEV.	2.1908902	1.5165751	1.7888544	1.3291601	1.9493589	**********	0.0000000	1.9493589	1.1547005	**********

****** = NO DATA

TABLE B-72. TOTAL COLIFORM (MPN) CONCENTRATIONS DETERMINED DURING 1976

PARAMETER: TOTAL COLIFORM MPN)   UNITS: COUNT/100 M

DATE	STATION NUMBER 1	2	3	4	5	6	7	8	9	10
JUNE 17, 1976	****			.160E+05					.110E+02	
JUNE 23, 1976	.110E+06			.900E+05					.310E+02	
JULY 7, 1976	.540E+07			.170E+05					****	
JULY 15, 1976	.490E+05			.500E+05					.220E+02	
JULY 22, 1976	.110E+06			.170E+04					.200E+03	
JULY 29, 1976	.220E+06			.200E+05					.500E+02	
AUG. 5, 1976	.500E+05			.500E+05					.500E+02	
AUG. 12, 1976	< .200E+03			.330E+05					.800E+02	
AUG. 20, 1976	.700E+04			.200E+05					.200E+03	
SEP. 2, 1976	.400E+05			.200E+05					.700E+03	
SEP. 10, 1976	.200E+03			.800E+05					.500E+02	
SEP. 17, 1976	.210E+05			.200E+05					.200E+03	
SEP. 24, 1976	.200E+05			.330E+05					.110E+04	
OCT. 1, 1976	.230E+06			.500E+04					.800E+02	
OCT. 8, 1976	.490E+05			.230E+04					.800E+02	
OCT. 15, 1976	.200E+04			.500E+04					.200E+02	
OCT. 22, 1976	.170E+05			.220E+05					.500E+02	
MAXIMUM	.540E+07			.900E+05					.110E+04	
MINIMUM	.200E+03			.170E+04					.110E+02	
GEOM. MEAN	.266E+05			.178E+05					.802E+02	
EXP. MEAN	< .112E+06			.236E+05					.113E+03	
ARITH. MEAN	< .395E+06			.285E+05					.183E+03	

**** = NO DATA

TABLE B-73. TOTAL COLIFORM (MPN) CONCENTRATIONS DETERMINED DURING 1977

[illegible] [illegible]

DATE	STATION NUMBER 1	2	3	4	5	6	7	8	9	10
MAY 7, 1977	****			****					****	
MAY 14, 1977	****			****					****	
MAY 21, 1977	****			****					****	
MAY 28, 1977	****			****					****	
JUNE 7, 1977	****			****					****	
JUNE 14, 1977	****			****					****	
JUNE 21, 1977	****			****					****	
JUNE 28, 1977	****			****					****	
JULY 5, 1977	****			****					****	
JULY 12, 1977	****			****					****	
JULY 19, 1977	****			****					****	
JULY 26, 1977	****			****					****	
AUG. 2, 1977	****			****					****	
AUG. 9, 1977	.790E+03			.350E+05					.220E+02	
AUG. 16, 1977	.160E+06			.790E+04					.200E+01	
AUG. 23, 1977	.[illegible]70E+04			.110E+05					****	
AUG. 30, 1977	.350E+06			.330E+05					.200E+01	
SEP. 6, 1977	****			****					****	
SEP. 13, 1977	.130E+05			.460E+04					****	
SEP. 20, 1977	.490E+05			.200E+04					****	
SEP. 27, 1977	.230E+04			.110E+05					****	
OCT. 5, 1977	.280E+05			.140E+05					****	
MAXIMUM	.350E+06			.350E+05					.220E+02	
MINIMUM	.790E+03			.200E+04					.200E+01	
GEOM. MEAN	.154E+05			.104E+05					.445E+01	
EXP. MEAN	.444E+05			.127E+05					.674E+01	
ARITH. MEAN	.756E+05			.148E+05					.867E+01	

**** = NO DATA

TABLE B-74. TOTAL COLIFORM (MF) CONCENTRATIONS DETERMINED DURING 1976

PARAMETER: TOTAL COLIFORM (MF) UNITS: COUNTS/100 ML

DATE	STATION NUMBER 2	3	4	5	6	7	8	9	10
JUNE 17, 1976	****		.900E+04					.200E+02	
JUNE 23, 1976	.[illegible]E+05		.810E+03					.200E+02	
JULY 7, 1976	.13[illegible]E+04		.120E+07					****	
JULY 15, 1976	.17[illegible]E+05		.970E+03					.200E+02	
JULY 22, 1976	.52[illegible]E+0[illegible]		.280E+03					.160E+02	
JULY 29, 1976	.390E+05		.160E+04					.240E+02	
AUG. 5, 1976	.950E+04		.160E+02					.260E+02	
AUG. 12, 1976	.330E+03		.450E+03					.940E+02	
AUG. 20, 1976	.100E+04		.590E+03					.460E+02	
SEP. 2, 1976	.130E+04		.860E+02					.400E+01	
SEP. 10, 1976	.100E+03		.650E+02					.800E+01	
SEP. 17, 1976	.480E+03		.310E+03					.100E+02	
SEP. 24, 1976	.180E+03		.200E+01					< .200E+01	
OCT. 1, 1976	****		< .200E+01					< .200E+01	
OCT. 8, 1976	.730E+04		.200E+01					.200E+01	
OCT. 15, 1976	.700E+03		.200E+01					< .200E+01	
OCT. 22, 1976	.170E+04		.270E+04					.200E+01	
MAXIMUM	.390E+05		.120E+07					.940E+02	
MINIMUM	.100E+03		.200E+01					.200E+01	
GEO. MEAN	.192E+04		.200E+03					< .937E+01	
HARM. MEAN	.38[illegible]E+04		< .307E+04					< .134E+02	
ARITH. MEAN	.654E+04		< .716E+05					< .186E+02	

**** = NO DATA

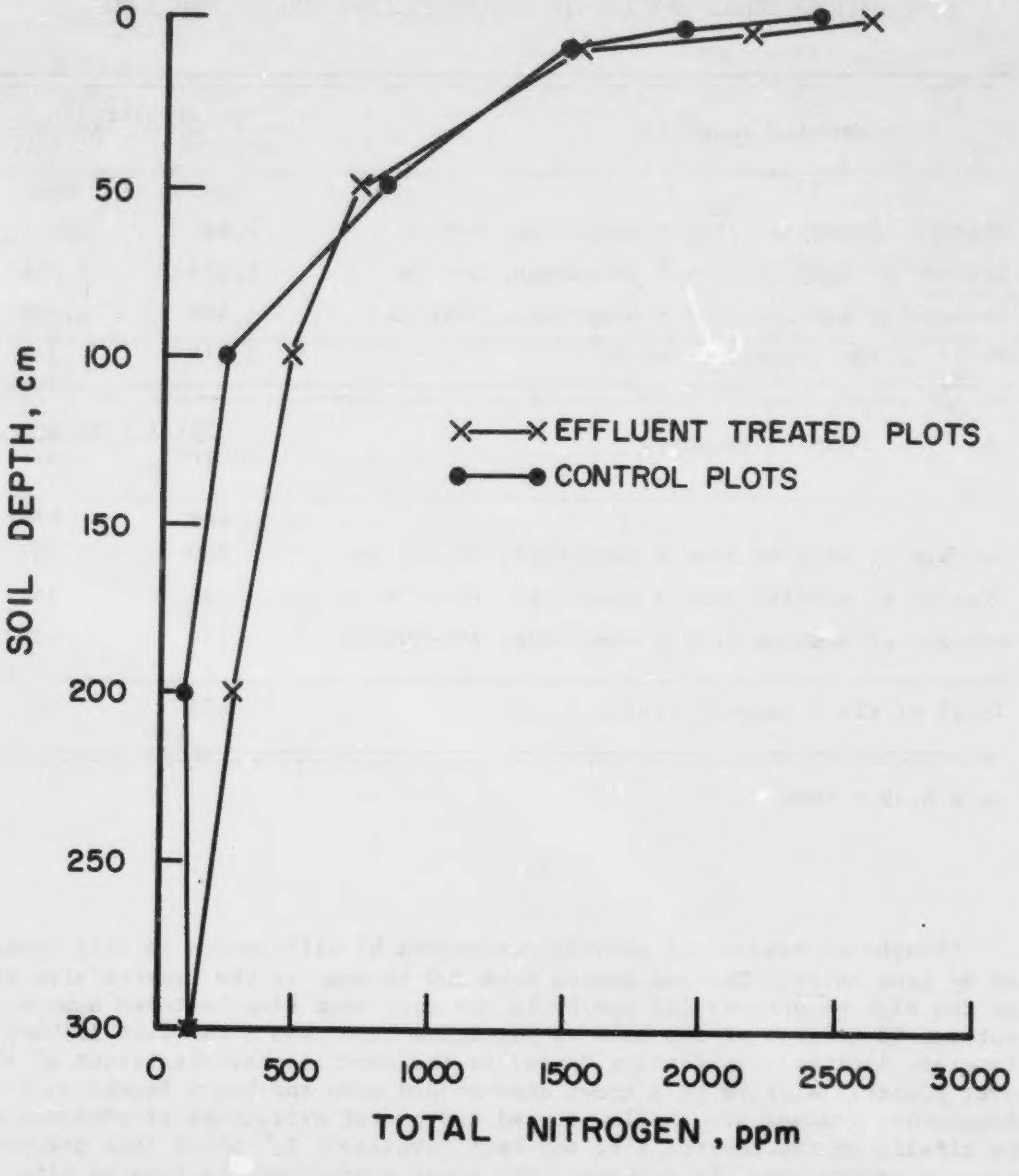


Figure 13. The total Kjeldahl nitrogen in soils from control and treated site sampled September 1976 and June 1977.

TABLE 30. CONCENTRATION AVERAGES OF PHOSPHORUS IN THE SODIUM BICARBONATE EXTRACT OF TOOELE SOIL SAMPLED JUNE 6, 1976

Soil Depth	Concentration of P (ppm)			Average
	Rep 1	Rep 2	Rep 3	
cm	Control Plots			
0-2	5	30	29	21.3
2-4	2	26	19	15.7
9-11	1	14	18	11.0
29-31	0	6	16	7.3
48-52	2	4	--*	3.0
70-80	0	3	--	3.0
95-105	1	3	4	2.7
150-160	2	--	--	--
195-205	--	7	--	7.0
230-240	--	2	--	2.0
295-305	--		--	--
	Treated Plots			
0-2	135	112	112	119.7
2-4	111	109	103	107.7
9-11	70	78	92	80.0
29-31	67	62	68	65.7
48-52	45	48	67	53.3
95-105	8	6	4	6.0
145-155				
195-205	4	9	5	6.0
295-305	6	9	22	12.3

*A dash means no soil sample was collected, either because it was not in the planned sampling or was to bouldery or too hard to penetrate to collect a sample.

cm x 0.39 = inch

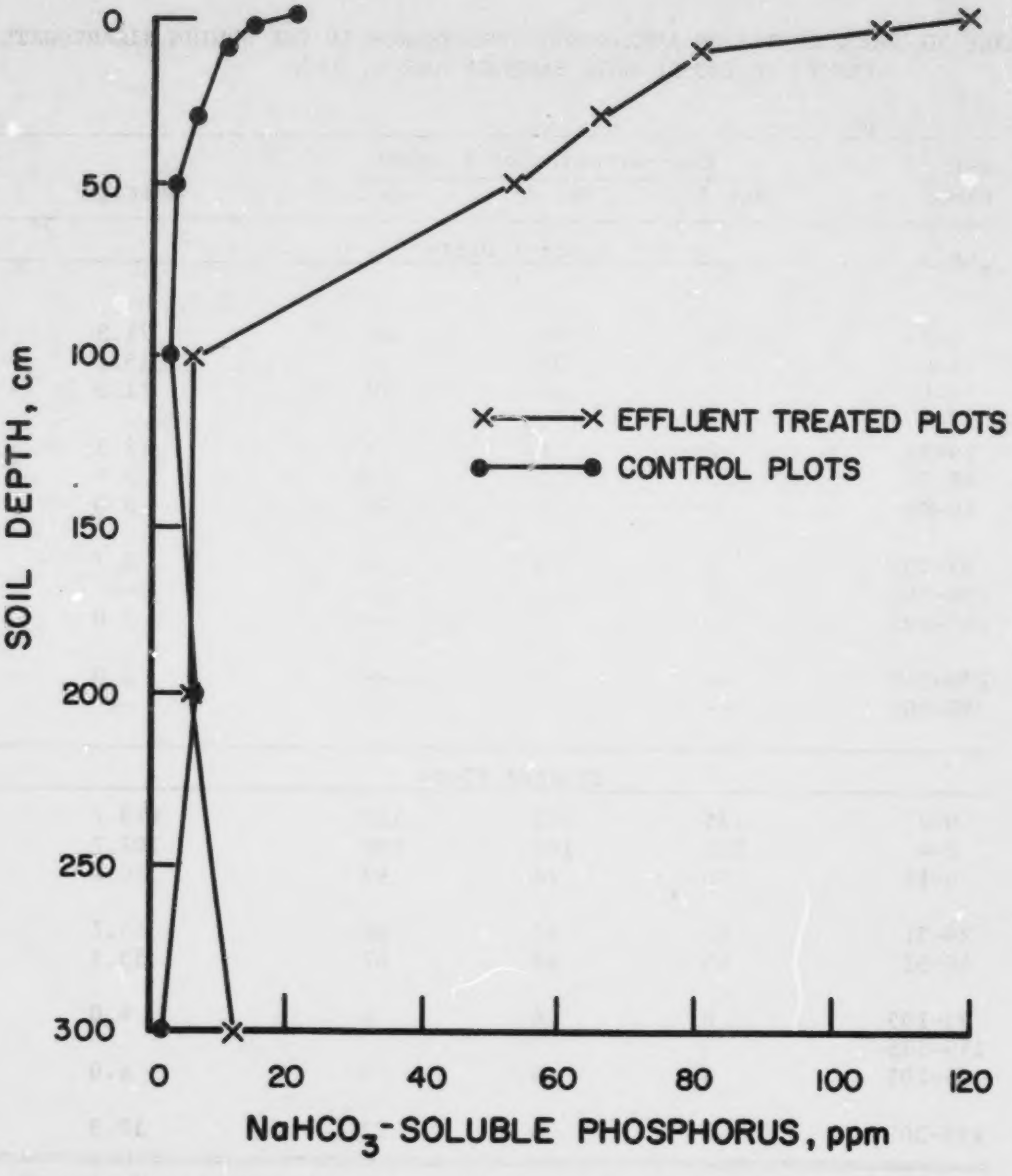


Figure 14. Sodium bicarbonate-soluble phosphorus extracted from the soils in the control and treated site (sampled June 1976).

Because the procedure suggested by EPA for phosphorus was extraction with dilute hydrochloric acid--ammonium fluoride solution, which is acidic and not satisfactory on calcareous soils (dissolves carbonates), a comparison of both methods on the non-calcareous surface samples is given in Table 31. It illustrates the larger values obtained using the sodium bicarbonate extractant. Both extractants extracted much more phosphorus from the surface 4 cm (1.6 inches) of soil in the soil samples from the treated site than those samples from the control site.

Nitrogen and Salts in Percolating Soil Water

Suction tubes (plastic tube with a porous porcelain tube on the bottom) were installed in the control site and treated site through the summer period. By applying suction, samples of soil solution were collected at the depth of the porous cups 45 or 60, 90 or 105, and 180 or 210 cm depth.

TABLE 31. COMPARISON OF THE PHOSPHORUS EXTRACTED BY THE PROCEDURE RECOMMENDED FOR ACIDIC SOILS (DILUTE HCl-NH_4F) AND THAT RECOMMENDED FOR CALCAREOUS AND ALKALINE SOILS (0.5 NORMAL $NaHCO_3$)

Sample Site	Soil Depth	HCl-NH_4F Extract			0.5 N $NaHCO_3$ Extract		
		1	2	Ave	1	2	Ave
	cm	ppm	ppm	ppm	ppm	ppm	ppm
Control 1	2-4	1.5	1.5	1.5	4.8	4.8	4.8
Control 2A	0-2	16.8	17.1	17.0	29.6	29.6	29.6
Control 2B	0-2	14.1	14.4	14.2	26.4	24.0	25.2
Control 3A	2-4	16.7	16.2	16.4	25.2	26.4	25.8
Control 3B	2-4	14.3	15.1	14.7	24.8	25.6	25.2
Control 3	0-2	22.3	21.4	21.8	30.4	27.2	28.8
Control 3	2-4	17.4	17.5	17.4	19.2	19.6	19.4
Treated 1	0-2	56.7	60.9	58.8	132	138	135
Treated 1	2-4	55.4	57.1	56.2	116	106	111
Treated 2	0-2	40.9	40.9	40.9	114	109	112
Treated 2	2-4	48.7	46.6	47.6	106	112	109
Treated 3	0-2	43.7	40.3	42.0	106	118	112
Treated 3	2-4	42.0	41.6	41.8	96	110	103

cm x 0.39 = inch

(18 or 24, 35 or 41, 71 or 83 inches). Some permanently installed tubes were placed in the garden plots. The mineral nitrogen and soluble salt contents of these water extracts are given in Tables 32 and 33 respectively.

The nitrogen contents show considerable variation, particularly in the treated site garden plot (partly because of mineral nitrogen fertilizers added to the control site garden plot). Also, the alfalfa residues plowed under in preparing the control site garden plot could also be decomposing to supply nitrogen. Most untreated deep soils in this area would contain about 1 to 3 parts per million (ppm) of mineral nitrogen below about 60 cm (24 inches) deep. Even values of 4 to 5 ppm are not unusual. It is obvious that the control site garden plots with added fertilizer were as well supplied with "available nitrogen" after fertilizer was added as were the treated site garden plots which had no fertilizer added. Or conversely, the treated site had as much nitrate plus ammonium in soil solution as did the control site after addition of 100 kg N/hectare (89 lbs N/acre) as fertilizer.

A comparison of Table 32 with Table 26 may appear inconsistent at first glance because mineral nitrogen in the soil (Table 26) is much lower in parts per million than are the solution extracts. Keep in mind; however, that values in Table 26 are based on soil weight and were taken prior to fertilization of the control site garden plots. If these nitrogen data were reported as ppm based upon water content only, (as in Table 32) the values could be three to five times higher than values given in Table 26. By July the crop was growing rapidly and mineral nitrogen would be decreased rapidly by these three actions:

1. Plant uptake,
2. Microbial use converting mineral nitrogen to "unmeasured" organic nitrogen forms,
3. Leaching losses or deeper movement.

Thus, there is no obvious way to compare mineral nitrogen contents in the June 1976 soil samples and in the soil extracts taken during July 1976 by soil moisture extractors.

The majority of samples outside the experimental garden plots (TF plots) had low soluble nitrogen levels suggesting low quantities of mobile nitrogen. Since these samples had to be taken within about 24 hours of irrigation in order to obtain solution and because irrigation water did not wet much beyond these depths, they are indicative of solution N levels.

In the garden plots where better moisture conditions were maintained and more water was added, some high soluble N values were obtained such as TG-1 at 180 cm (70 inches) depth on July 23, 1976 (=27 ppm N) and TG-2 at 90 cm depth on July 23, 1976 (=34 ppm N). Nitrogen is available for some leaching losses if frequent and adequate water applications are made.

In the 1977 growing season, a generalized drought condition hindered almost all irrigation of the control site (there was a limited supply of reservoir water) and only the treated site was irrigated appreciably. Even the treated site was irrigated less because of lower wastewater flow and a

TABLE 32. COMBINED NITRATE PLUS AMMONIUM NITROGEN IN SOIL MOISTURE EXTRACTS USING SUCTION CUPS

Site code symbol	Depth of suction cup	July 2, 1976	July 9, 1976	July 15, 1976	July 16, 1976	July 23, 1976	Oct. 15 1976
	(cm)	- - - - -	- - - - -	- - - - - -ppm-	- - - - -	- - - - -	- - - - -
CG-1	45	22	29		--[†]	30	
	90	9	11		13	13	
CG-2	45	110	172		--	--	
	90	81	--		102	91	
CG-3	45	--	49		--	57	
	90	--	30		35	37	
	180	--	8		--	13	
CG-4	45	41	39		--	17	
	90	30	27		20	--	
	180	3	--		7	5	
TG-1	45	32	--		7	7	
	90	6	7		--	11	
	180	--	--		--	27	
TG-2	45	35	34		42	--	
	90	5	--		--	34	
TG-3	45	31	6		--	4	
	90	6	7		13	19	
TG-4	45	2	--		9	2	
	90	7	--		--	--	
CF-5	30	6					
CF-6	30	7					
CF-7	30	21					
	75	35					
TF-5	60			7	--	13	25
	105			6	4	--	5
	210			--	3	--	--
FT-6	45			6	3	--	18
	105			4	5	--	5
	210			--	5	--	1
TF-7	60			5	--		4
	105			--	5		2
	210			--	--		1
TF-8	60			--	--	--	5
	120			--	--	--	8
	180			--	--	--	1

[*] CG and TF indicate control plots in the garden and treated plots in the garden; CF and TF indicate control plots and effluent treated plots in the pasture areas; numbers indicate different sampling sites.

[†] A dash indicates no sample could be collected; a blank indicates no collection was attempted.

cm x 0.39 = inch

TABLE 33. SOLUBLE SALT CONTENTS (CONDUCTIVITY) OF SOIL MOISTURE EXTRACTS USING SUCTION CUPS

Site code symbol*	Depth of suction cup	Salinity					
		July 2, 1976	July 9, 1976	July 15, 1976	July 16, 1976	July 23, 1976	Oct. 15, 1976
	(cm)	mmhos/cm					
CG-1	45	1	1		--[†]	1	
	90	1	1		1	1	
CG-2	45	1	1		--	--	
	90	1	--		1	1	
CG-3	45	--	1		1	1	
	90	--	1		--	1	
	180	--	2		--	2	
CG-4	45	1	1		--	--	
	90	1	1		1	1	
	180	2	--		2	1	
TG-1	45	1	--		2	1	
	90	1	--		--	2	
	180	--	--			2	
TG-2	45	1	2		2	--	
	90	1	--		--	1	
TG-3	45	2	3		--	1	
	90	2	2		2	1	
TG-4	45	2	--		--	1	
	90	1	--		1	--	
CF-5	30	1					
CF-6	30	1					
CF-7	30	1					
	75	1					
TF-5	60			1	--	--	2
	105			1	1	--	2
	210			--	2	--	--
TF-6	45			--	1	2	2
	105			2	2	--	2
	210			--	1	--	2
TF-7	60			1	--	--	2
	105			--	1	--	1
	210			--	--	--	1

*CG and TG indicate "control plots in the garden" and "treated plots in the garden"; CF and TF indicate control plots and effluent treated plots in the pasture areas; numbers indicate different sampling sites.

[†] A dash indicates no sample could be collected; a blank indicates no collection was attempted.

cm x 0.39 = inch

larger area being irrigated. Thus, most suction tubes were too deep to collect soil moisture because of small infrequent irrigation additions. The few samples collected produced no information different than the 1976 data.

Soluble salts in the suction water samples (Table 33) were all below 2 mmhos/cm except for one sample which had a conductivity of 3/mmhos/cm (treated site, on July 9, 1976). Although not tested by statistical analysis, the treated site appears to have a slight buildup of salt, but it is quite small.

An attempt was made to study the composition of soil solution and water infiltration from normal rainfall and irrigation by installation of lysimeters. Installation was made in October 1976. The drought resulted in a dry winter and minimal irrigation. Thus, when no water was in the bottom of the lysimeters by July 1977, water was applied to each lysimeter in measured amounts. The amount of water added to each lysimeter was estimated from the soil moisture constants determined in 1976. The water was added during a four to five day period. During the next 10 days, even with twice the estimated quantity of water added, only a few lysimeters collected sufficient water in the bottom for sampling. Apparently all six lysimeters developed leakage in the bottom (in spite of care to seat them on fine soil and use 3 or 4 thicknesses of plastic sheeting). Even lysimeters where water was collected would soon lose additional water. Although costly and time-consuming, this procedure produced no usable data.

Trace Metal Contents

The soil contents of lead, copper, nickel, cadmium, zinc, and chromium are summarized in Tables 34 and 35. Table 34 contains the results of an initial analyses of samples taken in 1976 and performed by analyst A. Table 35 are the same data performed using a larger acid-to-soil ratio, average values for all three sampling dates, and performed by analyst B. It is felt that the values in Table 35 are more representative than those in Table 34.

Analyses by analyst B do not include cadmium. Completely erratic results were obtained even after checking all chemicals, water sources, and three absorption spectrophotometers. The source of the problem could not be found and was in the prepared solutions. Values varied several hundred percent between duplicates. Yet, no other metals presented this same analytical problem (as indicated by good duplication).

Two smelters within 32 km (20 miles) of the field sites (International Lead and Kennecott Copper) have (for over 50 years) until recently (in the 1960's) emitted some vaporized forms of trace metals. Soil samples in previous studies from the areas have indicated accumulation of lead and presumably other metals have also settled on the soil. Typical lead concentrations in uncontaminated soil range from 10-20 ppm. The higher values measured in the soil surface of the control and treated sites are most likely fallout accumulation.

TABLE 34. AVERAGE PERCHLORIC-NITRIC ACID EXTRACTABLE TRACE METALS IN TOOELE SOILS SAMPLED MAY 1976 AND SEPTEMBER 1976 +

Sample Depth	Trace Metal (ppm)					
	Lead	Nickel	Zinc	Copper	Chromium	Cadmium
cm	Control Site					
0-2	48.3	17.0	73.3	24.0	26.3	3.7
2-4	43.5	15.7	71.5	24.7	26.5	2.2
9-11	35.5	13.7	65.5	17.3	18.8	3.7
28-32	20.0	15.3	55.3	15.0	22.8	2.2
45-55	16.0	17.0	45.8	12.3	18.2	2.5
95-105	15.3	13.0	29.5	7.3	13.0	4.0
195-205	7.8	4.5	10.0	4.0	7.0	--
205-305	12.0	17.0	36.0	17.0	13.0	--
Totals	198	113	387	122	14.6	18.3
	Treated Site					
0-2	43.5	15.3	72.3	17.3	21.7	3.4
2-4	43.3	16.3	74.0	22.3	24.2	3.3
9-11	35.7	16.7	66.7	20.3	28.0	2.8
28-32	19.3	18.7	52.5	11.7	30.5	3.0
45-55	18.2	16.7	46.7	11.7	26.7	3.9
95-105	17.3	13.7	41.2	9.0	23.7	4.7
195-205	15.6	16.7	43.3	10.7	25.0	1.0
295-305	14.0	16.0	24.7	8.3	10.2	2.3
Totals	207	130	421	111	19.0	21.1†

+Average of 6 site replications and with duplicate analyses per collected sample.

Some deeper depths of 45-55 cm and deeper have fewer than 6 sites. Cadmium and copper data are only 3 replications. Done by Technician A.

†Bottom two depths not included so it corresponds to depths included in control plots.

cm x 0.39 = inch

TABLE 35. AVERAGE PERCHLORIC-NITRIC ACID EXTRACTABLE TRACE METALS IN TOOELE SOILS SAMPLED JUNE 1976, SEPTEMBER 1976, AND JUNE 1977 +

Sample Depth	Trace Metal (ppm)				
	Lead	Nickel	Zinc	Copper	Chromium
cm	Control Site				
0-2	43.7	23.0	108.2	27.1	25.3
2-4	37.9	22.5	106.1	25.2	24.7
9-11	33.1	21.0	100.7	24.5	27.0
28-32	14.7	19.7	85.8	16.1	26.2
45-55	13.6	22.5	81.1	13.0	27.0
95-105	12.2	15.8	58.6	12.9	21.1
195-205	8.1	20.5	36.2	9.0	14.2
295-305	10.6	22.2	44.0	10.7	16.5
Totals	174	167	621	138	18.2
cm	Treated Site				
0-2	41.0	23.4	116.9	28.2	26.8
2-4	38.6	20.6	109.0	27.8	27.3
9-11	28.5	25.4	105.9	22.3	26.4
28-32	17.5	24.0	92.3	17.2	30.1
45-55	15.7	23.3	82.2	15.0	26.3
95-105	16.0	26.4	77.5	14.3	26.5
195-205	12.3	19.5	61.6	12.3	22.6
205-305	12.1	19.6	36.6	11.4	16.7
Totals	182	182	682	148	20.3

+Average of 9 site replications and with duplicate analyses per collected sample.

Some depths of 45-55 cm and deeper have fewer than 9 site replications. Done by Technician B.

cm x 0.39 = inch

All samples studied had higher concentrations of the six trace metals in surface soil layers than in the deeper samples. These concentrations were most noticeable for lead, copper, chromium, and zinc; less marked differences occurred in the different depths for nickel and cadmium. There were not large differences between metal contents in the control site and in the treated site. In fact, as the summary values of Tables 34 and 35 are compared, there are larger differences between metal contents obtained by the two different analysts and their procedures (soil:acid ratio) than there is between control samples and treated samples when measured by the same analyst.

The small differences between control and treated samples suggest that the effluent at Tooele has not been a cause of much metal accumulation. Actual concentration increases of the treated site samples over the control site samples are a maximum of about 30 percent for chromium and 24 percent for nickel in one set of data but about increases of 10 percent or less for all other comparisons.

Because of great differences in rock content and texture of the less-than-2 mm (0.08 inches) soil at greater depths in the various profile sites, it is difficult to compare total parts per million of one profile with other profiles at either the control site or the treated site. Only to depths generally of about 50 cm (20 inches) or, in most instances, 100 cm (39 inches) are the profiles similar, (i.e., all having low gravel content). To a depth of 55 cm (22 inches) there is not enough difference within the precision of sampling and analysis to indicate accumulation of metals in the site with sewage effluent (Table 36). When these data are compared by the top 5 depths only, total parts per million for samples for the control site are higher than totals for those from the treated site in four of the data pairs; the sample data from the treated site are higher than those of the control site in the other seven pairs.

Statistical summaries of the trace metal analyses to depths of 300 cm (118 inches) are given in Table 37. Because some of the greater depths could not be reached for samples in some pits, the analyses cannot be treated as it could if uniform samples had been collected for all depths. In Table 37 the analyses indicate the following:

1. All metals determined were significantly different for samples collected on the different sampling dates. This fact suggests that considerable variation occurs in the field and that date of sampling was really more a condition of sampling new locations than of changes in time of sampling.

2. Only zinc and chromium contents varied significantly (99% level) between the control site and the treated site. Nickel content was significantly different in the two sites at the 95 percent level. Both copper and lead were not statistically different (95% level) between the two sites.

3. All metals change (lower) in concentration with depth except nickel. This result is possible if no appreciable nickel is applied to the soil in effluent. This does not likely show a true picture. The metals

TABLE 36. COMPARISONS OF PROFILE TOTALS FROM 0 TO 55 CM (22 INCHES) OF REPLICATION AVERAGES FOR TRACE METALS IN THE CONTROL AND TREATED SITES

Analyst	Sites	Lead	Nickel	Zinc	Copper	Chromium	Cadmium
		ppm	ppm	ppm	ppm	ppm	ppm
A	Control	163*	79	311	93	113	14.3
	Treated	160	84	312	83	101	16.4
B	Control	143	109	482	106	130	No Data
	Treated	141	117	506	110	137	

*Summation of values for sample depths 0-2, 2-4, 9-11, 28-32, and 45-55 cm.

cm x 0.39 = inch

are given only as concentrations in the less-than-2 mm (0.08 inches) soil. The apparent concentrations per soil volume would decrease even more if rock volume was included because of the rock content in deeper soil layers unless the rocks also contained these levels of nickel (or other metals).

Because of the problems of variable rock contents in deeper profile layers and the inability to sample some depths, it was decided to test only the upper part of the soils, the 0 to 30 cm (0-12 inches) depths. This depth includes four sampling depths, the soils are of similar texture, and this is commonly the major depth to which these metals normally accumulate. Most of these metals are quite immobile and do not usually move deeply into soil profiles. The statistical summary is presented in Table 38. A number of conclusions of this test are given in the following, and some are different than shown in Table 37.

1. In testing only the top 32 cm (13 inches), zinc contents did not vary between sampling depths, although all other metals were still extracted in different amounts from samples of different dates. Also less-than-2 mm (0.08 inches) material was quite similar in all profiles as was observed in sampling.

2. In the top 30 cm (12 inches) none of the metals, except chromium at the 95 percent level, were different in the control site and treated site. This indicates that effluent additions have apparently not caused any easily

TABLE 37. STATISTICAL SUMMARY FOR ANALYSIS OF VARIANCE FOR THE TRACE METAL CONTENT AND LESS-THAN-2 MM PORTIONS FOR ALL SOIL DEPTHS TO 300 CM (118 INCHES) OF SOILS IN THE CONTROL AND TREATED SITES

Source	Source d.f.	Source mean square	Error mean square	Error d.f.	F-ratio
Date of sampling (are data of one sampling different than from others)					
Lead, ppm	2	192.517	57.8191	95	3.330*
Zinc, ppm	2	2456.897	112.7072	95	21.799**
Copper, ppm	2	211.938	7.7105	95	27.487**
Chromium, ppm	2	192.027	11.2145	95	17.123**
Nickel, ppm	2	247.334	20.8489	95	11.863**
% less than 2mm	2	708.461	201.0146	95	3.524*
Treatment (Do metal contents in control sites differ from those in treated sites)					
Lead, ppm	1	0.742	57.8191	95	1.284
Zinc, ppm	1	1562.043	112.7072	95	13.859**
Copper, ppm	1	22.386	7.7105	95	2.903
Chromium, ppm	1	164.048	11.2145	95	14.628**
Nickel, ppm	1	128.751	20.8489	95	6.175*
% less than 2mm	1	795.159	201.0146	95	3.956*
Depth (Do changes occur with depth)					
Lead, ppm	7	2,227.768	57.8191	95	38.530**
Zinc, ppm	7	7,636.285	112.7072	95	67.753**
Copper, ppm	7	600.594	7.7105	95	77.892**
Chromium, ppm	7	136.986	11.2145	95	12.215**
Nickel, ppm	7	28.662	20.8489	95	1.375
% less than 2mm	7	1,558.669	201.0146	95	7.754**

*Significant difference at the 95% confidence level
**Significant difference at the 99% confidence level

cm x 0.39 = inch

TABLE 38. STATISTICAL SUMMARY FOR SPLIT PLOT ANALYSIS OF VARIANCE FOR THE TRACE METAL CONTENT AND LESS-THAN-2 MM PORTIONS FOR THE TOP FOUR DEPTHS OF SOILS (0-32 CM) IN THE TOOELE SEWAGE-EFFLUENT DISPOSAL STUDY†

Source	Source d.f.	Source mean square	Error mean square	Error d.f.	F-ratio
Date of sampling (are data of one sampling different than from other)					
Lead, ppm	2	254.562	69.5768	12	3.659*
Zinc, ppm	2	191.259	197.8043	12	0.967
Copper, ppm	2	180.578	12.3073	12	19.672**
Chromium, ppm	2	73.679	10.4443	12	7.054**
Nickel, ppm	2	263.572	42.7997	12	6.158*
% less than 2mm	2	260.389	107.7083	12	2.418
Treatment (Do metal contents in control sites differ from those in treated sites)					
Lead, ppm	1	51.173	69.5768	12	0.735
Zinc, ppm	1	641.417	197.8043	12	3.242
Copper, ppm	1	8.750	12.3073	12	0.711
Chromium, ppm	1	61.420	10.4443	12	5.881*
Nickel, ppm	1	56.889	42.7997	12	1.329
% less than 2mm	1	1,275.125	107.7083	12	11.838**
Depth (Do changes occur with depth)					
Lead, ppm	3	2221.769	54.2511	36	40.953**
Zinc, ppm	3	1813.152	35.2678	36	51.411**
Copper, ppm	3	442.816	4.3470	36	101.867**
Chromium, ppm	3	17.423	8.9312	36	1.951
Nickel, ppm	3	13.408	16.5245	36	0.811
% less than 2mm	3	52.643	18.4676	36	2.851

*Significant difference at the 95% confidence level

**Significant difference at the 99% confidence level

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†Because some deeper samples were missing, only 0-2, 2-4, 9-11, and 28-32 cm depths are included in this comparison.

cm x 0.39 = inch

measurable buildup of trace metals, except possibly chromium, in these soils.

3. Even with little rock or gravel in the top 30 cm (12 inches), there is enough so that a highly significant difference exist between the percentages of less-than-2 mm (0.08 inches) soil in the control site and treated site.

4. Significant changes with depth from the top to 30 cm (12 inches) deep occurs only with lead, zinc, and copper. These are the prominent metals expected in the aerosol from the metal smelters during the first half of this century.

The conclusion from these results is that there is no clear evidence of increased lead, zinc, copper, or nickel contents in the treated site from effluent additions. Even the data for chromium suggest that any difference, (as is indicated) will be for larger amounts in the control site, rather than in the treated site (see previous tables summarizing trace metal analyses). Better replicated values, and selection of sites, and more similarity in rock content with depth may have resulted in a different conclusion, but such precision is not likely in this area and such similar sites are not available in the area.

Trace Metals in the Deep Drill Hole

The trace metal contents for samples from the deep drill hole are given in Table 39. These values indicate background or natural contents of these metals with depth. Relative values will be slightly higher than values given in previous tables because of the wider soil-acid ratio used here (1:30) compared to that used for previous data (1:20). Below the two samples collected in the top 122 cm (4 feet), there is no pattern of increase or decrease in concentrations. Changes are random and taken from materials varying widely in their texture, and likely their origins also.

Trace Metal Availability to Plants

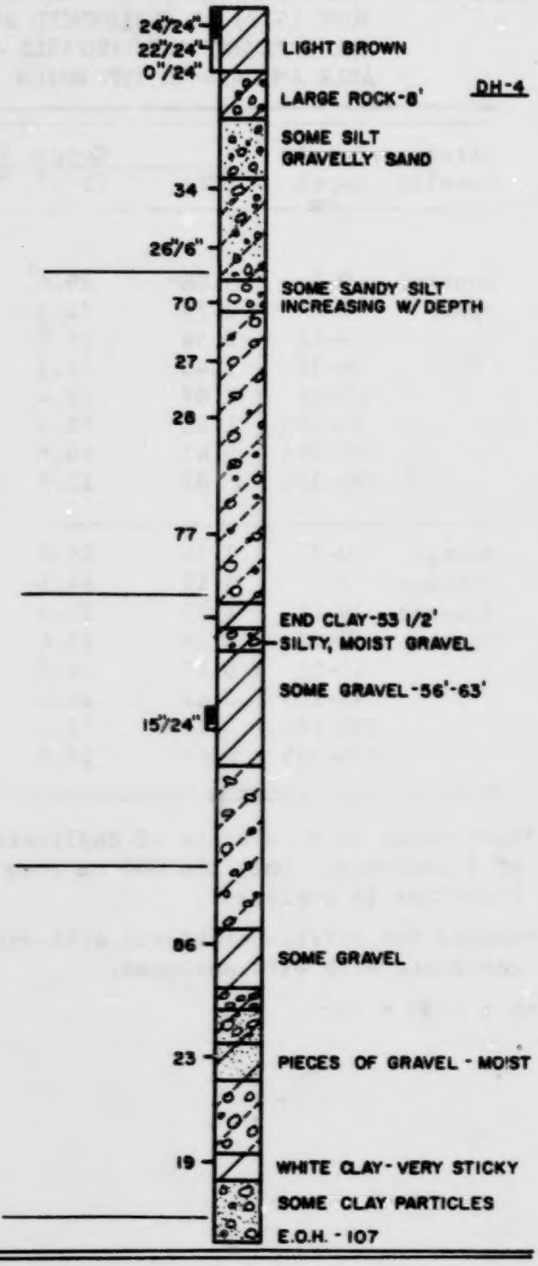
Tests for metal availability to plants were extractions with the chelate DTPA. These were performed only on June 1977 soil samples for the two plant nutrients, copper and zinc. These data are summarized in Table 40. There is no indication that more copper or zinc is being made available to plants from the treated site than from the control site. Neither the absolute quantity extracted nor the percentage extracted of the total present is different between the control and treated sites.

Implications for Long Term Effects

The treated site has not accumulated nitrogen, lead, zinc, copper, chromium, nickel, or soluble salts as a result of effluent additions.

The single measured soil property that increased, supposedly as a result of sewage effluent additions, was readily-available phosphorus. It is surprising that nitrogen does not show a similar increase. The cause of

TABLE 39. TRACE METAL CONCENTRATIONS IN VARIOUS FRACTIONS OF THE DEEP WELL PROFILE. ONLY PORTIONS OF SAMPLES OF LESS THAN 2 MM (0.08 IN.) SIZE MATERIAL WERE TESTED, TOOELE 1976

Soil Depth (feet)	Trace Metal Tested (ppm)					General Profile of Deep Well
	Lead	Nickel	Zinc	Copper	Chromium	
0-	30	63	65	19	37	
	20	64	57	18	31	
5-						
10-						
15-	23	45	22	11	20	
	26	53	16	6	14	
20	26	53	16	6	14	
25-	15	42	14	10	24	
30-	26	57	34	15	17	
35-	33	66	44	19	22	
40-						
45-	19	47	18	11	45	
50-						
	25	38	31	16	16	
55-						
60-	38	73	33	12	19	
65-						
70-						
75-						
80-	32	86	38	14	13	
85-						
90-	23	53	32	14	19	
95-						
100-	40	87	15	9	10	
105-						

24"/24"
22"/24"
0"/24"
LIGHT BROWN
DH-4
LARGE ROCK-8'
SOME SILT
GRAVELLY SAND
34
26"/6"
SOME SANDY SILT
INCREASING W/ DEPTH
70
27
28
77
END CLAY-53 1/2'
SILTY, MOIST GRAVEL
SOME GRAVEL-56'-63'
15"/24"
86
SOME GRAVEL
23
PIECES OF GRAVEL - MOIST
19
WHITE CLAY-VERY STICKY
SOME CLAY PARTICLES
E.O.H. - 107

TABLE 40. THE COPPER AND ZINC EXTRACTED FROM TOOELE SOIL SAMPLES (COLLECTED JUNE 1977) AS INFLUENCED BY SOIL DEPTH AND BY TREATMENT WITH SEWAGE EFFLUENT AND COMPARED TO TOTAL NITRIC PERCHLORIC ACID EXTRACTABLE AMOUNTS IN THE SOILS

Sites Sampled	Sample Depth cm	Copper (ppm)			Zinc (ppm)		
		DTPA	Total	Extracted	DTPA	Total	Extracted
Control Plots	0-2	3.08*	29.4†	10	6.53	113	6
	2-4	2.79	24.3	11	5.97	110	5
	9-11	2.54	21.9	12	4.85	104	4
	28-32	1.45	14.3	10	1.05	97	1
	45-55	1.07	13.4	8	0.99	85	1
	95-105	1.62	12.5	13	1.91	61	3
	195-205	0.82	10.9	8	0.95	65	1
	295-305	0.87	12.5	7	0.84	46	2
Sewage Effluent Treated Plots	0-2	2.76	26.8	10	5.91	115	5
	2-4	2.17	24.1	9	4.41	99	4
	9-11	1.75	22.0	8	3.13	99	3
	28-32	1.14	15.4	7	1.24	89	1
	45-55	0.87	12.6	7	0.79	84	1
	95-105	0.82	13.8	6	0.72	82	1
	195-205	0.74	11.5	6	1.13	68	2
	295-305	0.67	10.0	7	0.62	51	1

*Each value is an average of duplicate analyses for 3 replications, a total of 6 analyses. Only the 300 cm deep control sample is an average of 2 replications (4 analyses).

†Totals for nitric-perchloric acid extracts from June 1977 samples only to correlate with DTPA analyses.

cm x 0.39 = inch

this measured difference is unclear but is likely due to the soluble phosphates in detergents and other wastes in the effluent.

The long term application of secondary treated effluent does not appear to have had any negative effects on the soil chemical properties at the study site.

SECTION 6

RESULTS OF PLANT INVESTIGATIONS

INTRODUCTION

Application of sewage effluent to cropland usually benefits agriculture because of the value of sewage as a soil conditioner and as a source of many essential plant nutrients such as nitrogen, phosphorus and potassium. However sewage effluents often contain sizable amounts of zinc and other heavy metals (Berrow and Webber, 1972; Chaney, 1973; Melsted, 1973; Page, 1974). There is the possibility that the heavy metals might be toxic to crops and accumulate in edible crops sufficiently to have harmful effects on animals and humans. Land application of sewage effluents high in heavy metals could result in long-term phytotoxic effects and to food chain contamination. When these metals have been added to the soil there is downward movement, and therefore these metals tend to remain in the rooting zone (Page, 1974). Decontamination may be difficult, if not impossible, to achieve.

Investigations of the effects of toxic metals applied to soils have indicated that significant increases in metal concentrations of plant tissue as well as toxicities to the plants have resulted. For example, Halstead, Finn and MacLean (1969) found that the addition of nickel chloride at 100 ppm resulted in nickel concentration of 20 ppm in oat grain Avena sativa L., while Cropper (1969) indicated that the addition of chromium, copper, zinc and nickel as inorganic salts to a sandy soil decreased yields of corn. Soane and Saunder (1959) found that in sand cultures 10 ppm of chromium (as potassium dichromate) was toxic to corn.

Copper, zinc, and nickel appeared to be the metals most likely to become toxic to plants from sludge utilization (Webber, 1972). Lunt (1959) and Rhode (1962) attributed the poor growth of crops on sewage-amended soils to the toxicity of copper and zinc. King and Morris (1972) also indicated that copper and zinc toxicity was the reason for reduced growth of rye. Patterson (1971) found that land application of a sewage sludge high in nickel decreased yields, although liming the soil alleviated the problem. Webber (1972) later also confirmed the decreased toxicity of inorganic nickel salts as pH increased.

There have been few studies designed to evaluate the long-term effects of toxic metals applied in sewage effluents to soils (Page, 1974). Most research involving metal toxicity has been with short-term studies or with inorganic metal salts added to soils (Bazzaz et al., 1974; Bittell et al., 1974; Bradford et al., 1975; Carlson et al., 1975; Cunningham et al., 1975a, 1975b, 1975c; Day and Kirkpatrick, 1973; Giordano et al., 1975; Haghiri, 1974; Jones et al., 1975; King and Morris, 1973; Kirkham, 1975; Miles et al., 1972). Therefore, the purpose of this study was to assess whether the heavy metals present in the effluent water at Tooele, Utah, entered economically important plants. In addition, an attempt was made to determine (i) the accumulation of heavy metals in selected plants, (ii) in what part of the plant did heavy metals accumulate, (iii) the affect of heavy metals on plant growth, flowering and seed development, and (iv) were the amounts of heavy metals accumulated sufficiently high to be phytotoxic and harmful to animals and humans.

WATER QUALITY

A summary of the water quality applied to the treated garden plot and the control garden plot is presented in Table 41. A complete listing of the data is contained in Appendix B (Tables B-2 to B-83).

During 1976, the water applied to the treated garden plot originated from the second reservoir and flowed approximately 30 m (100 feet) through an open earthen ditch to the treated garden plot where it was sampled prior to flood irrigation of the plot (Sampling Station Number 5). A comparison of the 1976 treated garden plot influent data (Table 41) with the 1976 effluent from the second reservoir (Sampling Station Number 4) data (Table 13) indicates very little difference in the water quality of the two locations. This is not unexpected since the water only traveled 30 m (100 feet) between Sampling Stations 4 and 5. Thus, the discussions concerning the water quality of the treated site in Section 4 is also applicable to the treated garden plot.

The effluent from the treated garden plot (Sampling Station Number 6) or tailwater from the garden flood irrigation is generally of a poorer quality than the applied water. In 1976 effluent suspended solids concentrations averaged 1254.1 mg/l while the influent suspended solids averaged 64.6 mg/l. This increase in suspended solids is due to erosion or scour due to the flood irrigation of the row crops. This effluent scour tended to increase most of the water quality parameters. For this reason, sprinkler irrigation of the treated garden plot was practiced during the 1977 growing season.

The control garden plot was flood irrigated during the early 1976 growing season only (i.e., June 1976) and was sprinkler irrigated during the remainder of the 1976 growing season and all of the 1977 growing season. The influent to the control garden plot was identical to the influent to the control site. Thus, Sampling Stations 9 and 11 are identical and the discussion in Section 5 concerning the water quality of the control site is also applicable to the control garden plot.

The effluent quality from the control garden plot (Sampling Station Number 10) is reported in Table 41. In general, the effluent is of poorer quality than the influent. This is due to erosion or scour caused by flood irrigation of row crops. It should be noted that, the data for the effluent from the control garden plot (Sampling Station Number 10) is very limited

TABLE 41. SUMMARY OF WATER QUALITY OF APPLIED WATER TO THE CONTROL AND TREATED GARDEN PLOTS

Parameter, Units	Treated Garden Plot				Control Garden Plot				Recommended Limit (EPA, 1973)
	Influent (Station No. 5)		Effluent (Station No. 6)		Influent (Station No. 9)		Effluent (Station No. 10)		
	1976	1977	1976	1977	1976	1977	1976	1977	
Alkalinity, mg/l	255.8	246.8	287.6	+	201.1	197.7	-	+	
Calcium, mg/l	221.9	205.3	227.7	+	176.1	146.2	170.0	+	
Chloride, mg/l	134.3	147.1	139.5	+	21.2	22.0	18.8	+	5-40 meq/l
Hardness, mg/l	263.3*	251.9	269.1	+	224.4	179.8	222.0	+	
NH$_3$-N, mg/l	5.95*	3.27	4.76	+	0.046	0.057	0.091	+	
NO$_2$-N, mg/l	1.069*	0.776	1.115	+	0.0044*	0.0143	0.0071	+	
NO$_3$-N, mg/l	5.79*	8.46	5.48	+	0.495	0.418	1.171	+	
TKN, mg/l	8.69*	6.31	13.41	+	0.48	1.02	7.34	+	
Total Phosphorus, mg/l	9.46	9.59	19.90	+	0.046	0.079	2.126	+	
Total Soluble Phosphorus, mg/l	8.75	8.84	8.29	+	0.027	0.030	0.084	+	
Ortho-phosphate, mg/l	8.41	8.56	8.30	+	0.018	0.022	0.065	+	
Total Dissolved Solids, mg/l	610.2	618.0	619.6	+	253.2	272.0	326.0	+	500-1000 mg/l
Total Suspended Solids, mg/l	64.6	18.8	1254.1	+	2.2	5.8	-	+	
Volatile Suspended Solids, mg/l	16.8	14.3	89.0	+	1.6	2.6	-	+	
Specific Conductance, µmhos/cm	1113	1089	1106	+	497*	456	476	+	750-1500
Sulfate, mg/l	66.8	64.0	66.5	+	22.7	18.5	23.3	+	
BOD$_5$, mg/l	12.1	13.4	17.2	+	1.6	2.5	4.2	+	
COD, mg/l	60.1	60.5	196.8	+	9.53	21.02	181.4	+	
Temp, °C	20.7	20.6	22.3	+	16.3	29.2	15.0	+	
Dissolved Oxygen, mg/l	7.5	5.0	8.2	+	8.1	5.1	8.6	+	
pH, Units	7.6	7.2	7.8	+	7.4	7.3	7.0	+	4.5 - 9.0
Aluminum, µg/l	150	111	190	+	154	224	330	+	20,000
Cadmium, µg/l	0.3	<4.6	0.3	+	0.2*	<4.3	0.3	+	50
Chromium, µg/l	22	<12	12	+	5	<11	2	+	1,000
Copper, µg/l	13.8	<42.3	11.0	+	4.8*	<12.2	5.5	+	5,000
Iron, µg/l	56	25	28	+	23	230	66	+	20,000
Lead, µg/l	3.2	<0.9	3.0	+	2.8	<0.9	3.5	+	10,000
Magnesium, mg/l	10.1*	25.2	11.3	+	11.8*	22.1	13.2	+	-
Manganese, mg/l	21	10	15	+	12	<6	8	+	10,000
Mercury, µg/l	8.3	<1.5	5.1	+	6.5	<4.6	3.6	+	-
Potassium, µg/l	10.5*	12.5	11.1	+	1.0*	2.0	3.3	+	-
Silver, mg/l	<1.2	<5.7	<1.0	+	<1.0	<5.5	<1.0	+	4-8
Sodium, mg/l	118*	139	122	+	18	20	19	+	SAR < 4.8
Zinc, µg/l	<2.4	28	<20	+	<11	21	<13	+	10,000
Arsonic, µg/l	≠	1.6	≠	+	≠	14.8	≠	+	2,000
Nickel, µg/l	≠	<4	≠	+	≠	<2	≠	+	2,000

- No data
* 1976 mean is significantly different (95 percent level) from the 1977 mean
+ No runoff in 1977; plots were sprinkler irrigated
≠ Analysis not performed in 1976

(see Appendix B) because flood irrigation of the control garden plot was only practical for a short period of time.

The amount of water applied to the treated garden plot in 1976 is unknown because that data was lost in the accidental fire. During 1977, average rate of application to the treated garden plot was 5.1 cm/week (2.0 in/week), assuming even distribution of water by the sprinklers. The average application rate for the control garden plot, assuming even distribution of water by the sprinklers, was 6.2 cm/week (2.4 in/week) in 1976 and 8.6 cm/week (3.4 in/week) in 1977.

A review of Table 41, indicates that the water applied to the treated garden plot was of poorer quality than the water applied to the control garden. In general, however, the water applied to both plots was within recommended limits (EPA, 1973) established for irrigation water.

PLANT RESULTS FROM GARDEN PLOTS

Alfalfa

Alfalfa, Medicago sativa L., planted on the treated site emerged on about the same day as on the control site during both growing seasons. Weekly growth data, measured to the nearest centimeter, are shown in Table 42 and Figure 15 for 1976 and in Table 43 and Figure 16 for 1977. The height of plants on the effluent site were significantly greater for both seasons. This significance carried over when the fresh and dry weights were recorded for the first harvest (Tables 44 and 45). There were no differences, however, in the percent of moisture or in the leaf/stem (L/S) ratios. When fresh weight data for the first harvest of 1976 and 1977 are combined there is a highly significant difference (1 percent level) between years and a significant difference (5 percent level) with treatment (Table 46). Combined dry weight data for the two years likewise show significant difference for years and treatment (Table 47). There was no significant interaction between years times treatment with either fresh or dry weights. Combined analysis of the leaf/stem (L/S) ratio of the first harvest for 1976 and 1977 did not show significant differences (Table 48).

In 1976, there was no difference in the recovery growth the first week following the first harvest (Table 49 and Figure 17). However, plant height on the treated site was significantly higher thereafter. Differences in the recovery of alfalfa, as expressed by plant height, on the control and treated sites were highly significant (1 percent level) following the first harvest in 1977 (Table 50 and Figure 18). In 1976, fresh and dry weights percent moisture and L/S ratios were all significantly different (5 percent level) for the second harvest of alfalfa (Table 51). These parameters, however, were not significantly different (5 percent level) for the second harvest of alfalfa in 1977 (Table 52). Combined analysis of the 1976 and 1977 fresh weight data for the second harvest showed only a significant difference (5 percent level) at the treatment level (Table 53). Combined dry weight second harvest data showed significant differences with year, treatment, and interaction of year times treatment (Table 54). Combined L/S ratio data was significant (5 percent level) only with treatment for the two years (Table 55).

Chemical analysis showed significantly greater amounts of iron and zinc in the stems of the first and second harvest produced on the control site (Table 133). Significantly (5 percent level) greater amounts of sodium were accumulated in stems produced on the treated site from both harvests. Significantly (5 percent level) higher amounts of copper were detected in the stems of plants from the treated site after the second harvest. In leaves from the first harvested alfalfa plants produced on the control site, there were highly significantly (1 percent level) higher quantities of copper, iron, and zinc, whereas leaves produced on the treated site accumulated highly significantly (1 percent level) greater amounts of sodium. In the second harvest, leaves produced on the treated site showed significantly (1 percent level) more potassium, but less copper than did leaves produced on the control site.

TABLE 42. INFLUENCE OF SEWAGE EFFLUENT ON MEAN WEEKLY GROWTH (HEIGHT - CM) OF FIRST GROWTH (FIRST CUTTING) OF ALFALFA, 1976

Date	Control			Treated		
	$\overline{X}$	±	SE	$\overline{X}$	±	SE
May 8, 1976	0.25		0.00	0.29*		0.01
May 15, 1976	0.74		0.04	0.53**		0.02
May 22, 1976	1.33		0.07	1.88**		0.10
May 28, 1976	1.78		0.21	2.81**		0.20
June 5, 1976	8.35		0.31	12.75**		0.35
June 15, 1976	12.70		0.56	19.13**		0.42
June 22, 1976	18.00		0.85	23.28**		1.09
June 29, 1976	19.78		0.52	26.35**		0.93
July 8, 1976	30.08		0.85	35.20**		1.57
July 15, 1976	35.00		1.87	47.15**		1.06

*, ** = Significantly different at 0.05 and 0.01 level, respectively.

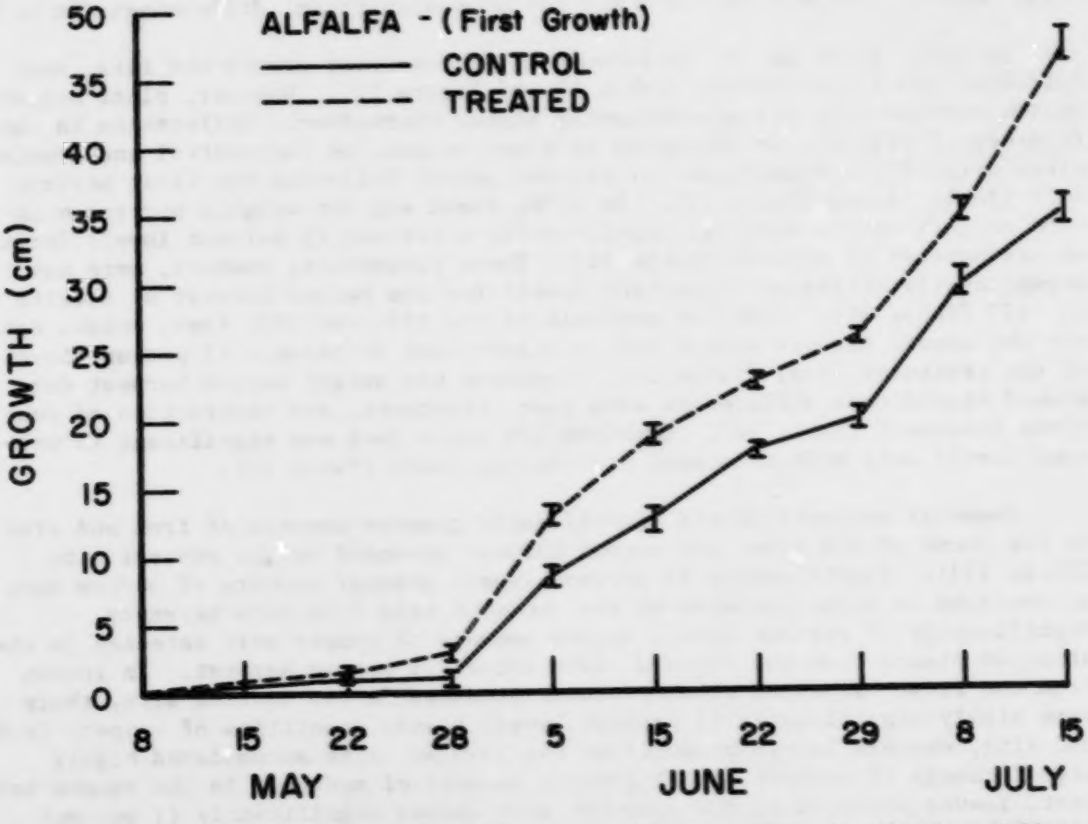


Figure 15. Influence of sewage effluent on first growth of alfalfa, 1976.

TABLE 43. INFLUENCE OF SEWAGE EFFLUENT ON MEAN WEEKLY GROWTH (HEIGHT - CM) OF FIRST GROWTH (FIRST CUTTING) OF ALFALFA, 1977

Date	Control		Treated	
	$\overline{X}$	± SE	$\overline{X}$	± SE
June 8, 1977	2.73	0.12	4.35**	0.23
June 14, 1977	3.58	0.17	7.95**	0.25
June 21, 1977	6.83	0.31	13.65**	0.32
June 28, 1977	13.48	0.55	24.73**	0.77
July 5, 1977	17.15	0.52	31.78**	1.10
July 12, 1977	17.45	0.81	30.75**	1.56
July 22, 1977	21.10	1.10	35.78**	1.65

** = Significantly different at the 0.01 level.

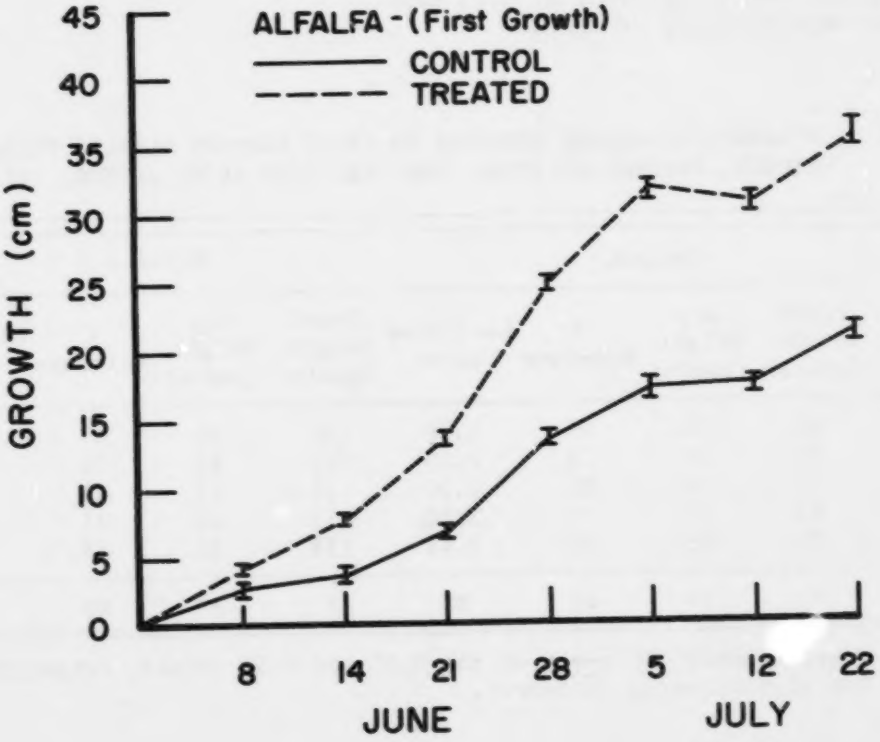


Figure 16. Influence of sewage effluent on first growth of alfalfa, 1977.

TABLE 44. INFLUENCE OF SEWAGE EFFLUENT ON FIRST HARVEST ALFALFA FRESH AND DRY WEIGHTS, PERCENT MOISTURE, AND LEAF/STEM RATIOS, 1976

Blocks	Control				Treated			
	Fresh Weight (gms/m)	Dry Weight (gms/m)	% Moisture	Leaf/Stem Ratio	Fresh Weight (gms/m)	Dry Weight (gms/m)	% Moisture	Leaf/Stem Ratio
I	110	34	69	2.54	491	83	83	2.09
II	343	65	81	1.97	353	61	83	2.20
III	233	49	79	2.36	845	138	84	1.44
IV	109	23	79	3.09	535	103	81	1.78
$\overline{X}$	199	43	77	2.49	556	96	83	1.88
	*	*	NS	NS	*	*	NS	NS

* = Significantly different at 0.05 level.
NS = Not significantly different.

TABLE 45. INFLUENCE OF SEWAGE EFFLUENT ON FIRST HARVEST ALFALFA FRESH AND DRY WEIGHTS, PERCENT MOISTURE, AND LEAF/STEM (L/S) RATIOS, 1977

Blocks	Control				Treated			
	Fresh Weight (gms/m)	Dry Weight (gms/m)	% Moisture	Leaf/Stem Ratio	Fresh Weight (gms/m)	Dry Weight (gms/m)	% Moisture	Leaf/Stem Ratio
I	80	30	61	1.90	150	65	57	2.12
II	83	28	70	2.45	245	63	74	2.16
III	32	14	56	2.30	82	27	67	1.84
IV	93	27	71	3.00	157	45	71	1.56
$\overline{X}$	72	25	65	2.41	158	50	68	1.92
	*	**	NS	NS	*	**	NS	NS

*, ** = Significantly different at the 0.05 and 0.01 levels, respectively.
NS = Not significantly different.

TABLE 46. COMBINED ANALYSIS OF FIRST HARVESTS OF ALFALFA FRESH WEIGHTS FOR 1976 AND 1977

Source	DF	SS	MS	F
Replications (R) Within Year	6	83,668.37	13,944.73	<1.00
Year (Y)	1	274,549.80	274,549.80	16.61**
Treatment (T)	1	196,714.43	196,714.43	11.90*
Y x T	1	73,343.40	73,343.40	4.44 NS
Rep x T	6	99,156.93	16,526.16	
Total	15	727,432.93	---	
Correction Factor	1	969,387.93	---	
Uncorrected Total	16	1,696,820.86		

*,** = Significantly different at the 0.05 and 0.01 levels, respectively.
NS = Not significantly different.

TABLE 47. COMBINED ANALYSIS OF FIRST HARVESTS OF ALFALFA DRY WEIGHTS FOR 1976 AND 1977

Source	DF	SS	MS	F
Replications (R) Within Year	6	2,453.68	408.95	<1.00
Year (Y)	1	4,042.10	4,042.10	8.65*
Treatment (T)	1	6,142.64	6,142.64	13.14*
Y x T	1	836.12	836.12	1.79 NS
R x T	6	2,803.96	467.33	
Total	15	16,278.50	---	
Correction Factor	1	45,722.20	---	
Uncorrected Total	16	62,000.70		

* = Significantly different at the 0.05 level.
NS = Not significantly different.

Beans

Snap beans, Phaseolus vulgaris L., planted on the treated site emerged on about the same days as those planted on the control site in 1976. Weekly growth data are shown in Table 56 and Figure 19. Although plants grown on the treated site were taller throughout the season, these differences were significant only on 6-5-76, 6-15-76, 6-23-76, (all 1 percent level) and 7-8-76 (5 percent level).

Entire plants were harvested and fresh and dry weights of plants, pods and seeds recorded (Table 57). Although plants from the control site had greater fresh and dry weights of pods and seeds than did those on the treated

TABLE 48. COMBINED ANALYSIS OF FIRST HARVESTS OF ALFALFA LEAF/STEM (L/S) RATIOS FOR 1976 AND 1977

Source	DF	SS	MS	F
Replications (R) Within Years	6	0.47	0.08	<1.00
Year (Y)	1	0.00	0.00	0.00
Treatment (T)	1	1.22	1.22	5.30 NS
Y x T	1	0.02	0.02	<1.00
R x T	6	1.38	0.23	
Total	15	3.09	--	
Correction Factor	1	75.69	--	
Uncorrected Total	16	78.78		

NS = Not significantly different.

site, these differences were not significant. The plants on the treated site exhibited greater top growth than did those on the control, i.e., they were bushier. Percentage moisture was about the same in plant parts from both sites.

In beans, the components of yield are in order of their development, the average number of pods per plant or per unit area, the average number of seeds per pod, and the average seed size (weight). When the data are viewed in this manner, only the average number of pods per plant exhibited a significant difference (1 percent level) due to treatment (Table 58). The product of the components is yield. Using the mean values of these components, we can calculate 9.70 gms per meter (0.0065 lbs/foot) for the control site and 4.82 gms per meter (0.0032 lbs/foot) for the treated site, or about a 50 percent decrease in seed yield in plants grown on the treated site as compared to those on the control site in 1976. For the most part, reductions in the average number of pods per plant and average number of seeds per pod were accompanied by an increase in seed weight (Table 59). In comparing the yield component data for the two sites in 1977, the control site had a yield of 4.55 gms per meter, while the treated site yielded only 3.48 gms, or 24 percent less than the control site.

In 1977, the growth responses observed for beans in the control and treated sites were similar to those in 1976 (Table 59, Figure 20). Significant differences in plants grown on the two sites were sporadic. When plants were harvested there were no differences observed in fresh or dry weights of plants, pods, or seeds produced on the two sites (Table 60). Likewise, no differences were observed in the components of yield, namely pods per plant, seeds per pod or seed weight (Table 61).

When the data for fresh weights of bean plants for 1976 and 1977 were combined, significant variations observed were due to year (1 percent level) and year times treatment (5 percent level) (Table 62). With dry weight data for both years, the only difference (1 percent level) observed was due to

TABLE 49. INFLUENCE OF SEWAGE EFFLUENT ON MEAN WEEKLY GROWTH (HEIGHT - CM) OF SECOND GROWTH (SECOND CUTTING) OF ALFALFA, 1976

Date	Control			Treated		
	$\bar{X}$	±	SE	$\bar{X}$	±	SE
July 22, 1976	10.05		0.55	11.50		0.61
July 29, 1976	17.65		0.49	23.85**		0.68
August 5, 1976	25.68		1.07	33.30**		0.82
August 12, 1976	27.93		1.54	49.23**		0.72

** = Significantly different at the 0.01 level.

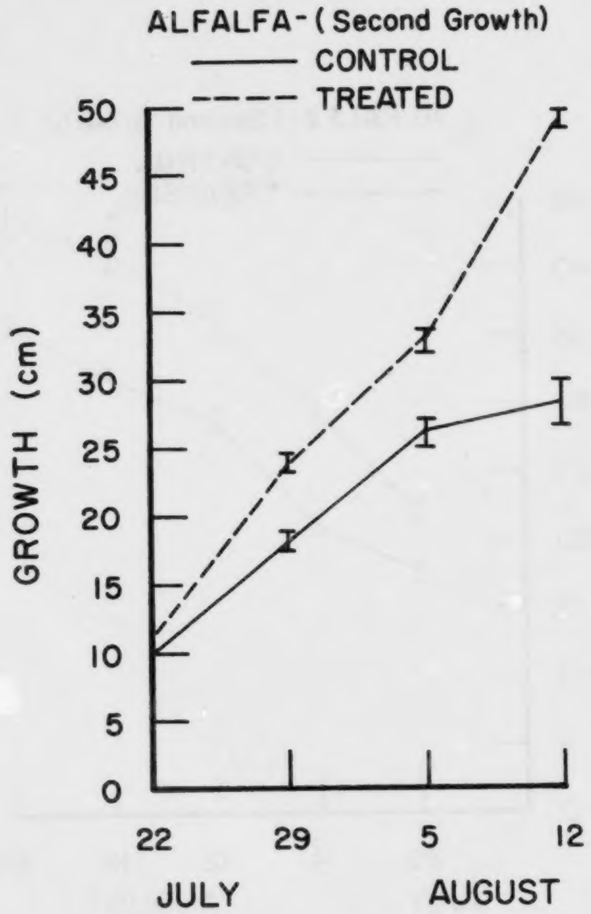


Figure 17. Influence of sewage effluent on second growth of alfalfa, 1976.

TABLE 50. INFLUENCE OF SEWAGE EFFLUENT ON MEAN WEEKLY GROWTH (HEIGHT - CM) OF SECOND GROWTH (SECOND HARVEST) OF ALFALFA, 1977

Date	Control		Treated	
	$\overline{X}$	± SE	$\overline{X}$	± SE
July 29, 1977	17.80	0.65	22.20**	0.78
August 4, 1977	21.35	0.79	29.95**	1.12
August 12, 1977	29.00	0.89	36.58**	1.45
August 19, 1977	32.00	0.94	41.58**	1.21
August 26, 1977	36.25	1.07	44.50**	1.84

** = Significantly different at the 0.01 level.

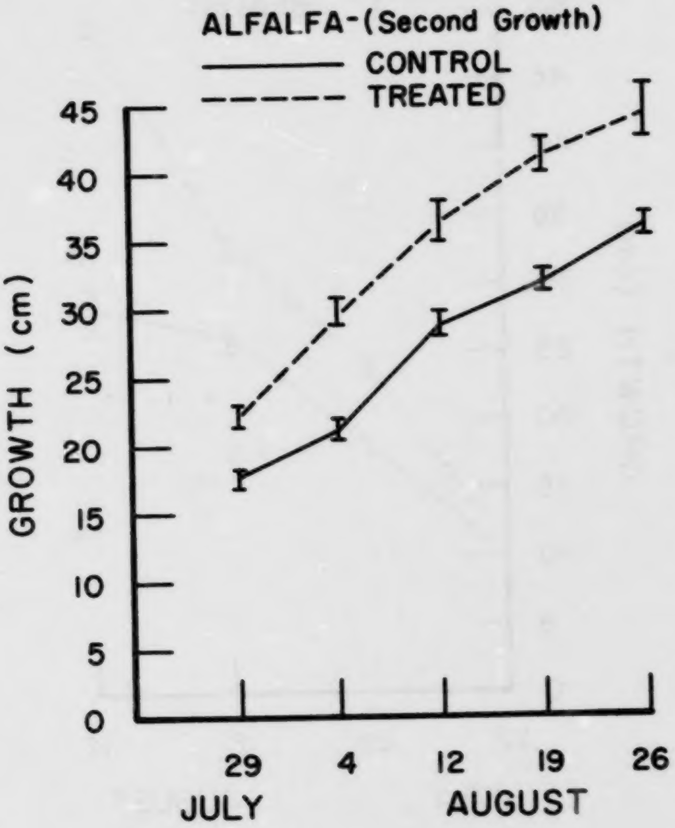


Figure 18. Influence of sewage effluent on second growth of alfalfa, 1977.

TABLE 51. INFLUENCE OF SEWAGE EFFLUENT ON SECOND HARVEST ALFALFA FRESH AND DRY WEIGHTS, PERCENT MOISTURE, AND LEAF/STEM RATIOS, 1976

Blocks	Control				Treated			
	Fresh Weight (gms/m)	Dry Weight (gms/m)	% Moisture	Leaf/Stem Ratio	Fresh Weight (gms/m)	Dry Weight (gms/m)	% Moisture	Leaf/Stem Ratio
I	380	60	84	2.16	555	437	21	1.50
II	434	196	55	2.32	486	363	25	1.28
III	452	279	38	2.53	552	448	19	1.57
IV	452	299	34	2.15	500	365	27	1.59
X̄	430	209	53	2.29	523	403	23	1.49
	*	*	*	**	*	*	*	**

*, ** = Significantly different at 0.05 and 0.01 levels, respectively.

TABLE 52. INFLUENCE OF SEWAGE EFFLUENT ON SECOND HARVEST ALFALFA FRESH AND DRY WEIGHTS, PERCENT MOISTURE, AND LEAF/STEM RATIO, 1977

Blocks	Control				Treated			
	Fresh Weight (gms/m)	Dry Weight (gms/m)	% Moisture	Leaf/Stem Ratio	Fresh Weight (gms/m)	Dry Weight (gms/m)	% Moisture	Leaf/Stem Ratio
I	545	132	76	1.59	498	111	78	2.26
II	301	76	75	2.04	547	134	83	0.94
III	234	54	77	2.38	238	67	72	1.31
IV	392	81	79	1.53	630	134	79	1.63
X̄	368	86	77	1.89	478	112	78	1.53
	NS	NS	NS	NS	NS	NS	NS	NS

NS = Not significantly different.

TABLE 53. COMBINED ANALYSIS OF SECOND HARVESTS OF ALFALFA FRESH WEIGHTS FOR 1976 AND 1977

Source	DF	SS	MS	F
Replications (R) Within Year	6	106,955.87	17,825.98	2.65 NS
Year (Y)	1	11,358.23	11,358.23	1.69 NS
Treatment (T)	1	41,748.70	41,748.70	6.20*
Y x T	1	283.08	283.08	<1.00
R x T	6	40,400.79	6,733.47	
Total	15	200,987.37	---	
Correction Factor	1	3,236,131.16	---	
Uncorrected Total	16	3,437,118.53		

* = Significantly different at the 0.05 level.
NS = Not significantly different.

TABLE 54. COMBINED ANALYSIS OF SECOND HARVESTS OF ALFALFA DRY WEIGHTS FOR 1976 AND 1977

Source	DF	SS	MS	F
Replications (R) Within Year	6	20,191.99	3,365.33	<1.00
Year (Y)	1	171,789.53	171,789.53	37.33**
Treatment (T)	1	48,631.28	48,631.28	10.57*
Y x T	1	28,552.54	28,552.54	6.20*
R x T	6	27,613.66	4,602.28	
Total	15	296,779.00	---	
Correction Factor	1	654,521.45	---	
Uncorrected Total	16	951,300.45		

*,** = Significantly different at the 0.05 and 0.01 levels, respectively.

TABLE 55. COMBINED ANALYSIS OF SECOND HARVESTS OF ALFALFA LEAF/STEM (L/S) RATIOS FOR 1976 AND 1977

Source	DF	SS	MS	F
Replications (R) Within Years	6	0.34	0.06	<1.00
Year (Y)	1	0.12	0.12	<1.00
Treatment (T)	1	1.33	1.33	6.34*
Y x T	1	0.22	0.22	1.05
R x T	6	1.23	0.21	
Total	15	3.24	--	
Correction Factor	1	51.77	--	
Uncorrected Total	16	55.01		

* = Significantly different at the 0.05 level.

year (Table 63). Combined bean pod fresh weight data for the two years registered a significant difference (5 percent level) due to year, whereas the dry weight data were not significant (Tables 64 and 65). When the bean seed fresh (Table 66) and dry (Table 67) weight data were combined, significant differences (1 percent level) again resulted from variation between years. The number of seeds per pod on the two sites for 1976 and 1977 were not significantly different (Table 68).

Chemical analysis of the entire bean plant grown on the treated site showed a significantly (5 percent level) higher amount of sodium, but less (1 percent level) zinc in 1976 (Table 133). There were no differences in accumulation of other chemicals. In pods from plants grown on the treated site, there were significantly greater amounts of calcium (5 percent level), potassium (1 percent level), and phosphorus (1 percent level), but significantly (1 percent level) less amounts of zinc. Seed produced on the treated site accumulated a significantly greater amount of sodium (5 percent level), but again less (1 percent level) zinc.

Carrots

Carrots, *Daucus carota* L., planted on the treated site emerged on about the same day as on the control site. Weekly growth data are shown in Table 69 and Figure 21. Plants grown on the treated site exhibited significantly greater height from May 22, 1976, through June 23, 1976, and again from July 15, 1976, through August 19, 1976. Entire plants were harvested and fresh and dry weights of shoots and roots, percent moisture and number of plants per meter recorded (Table 70). Fresh weight and the percent moisture of shoots and roots from plants produced on the treated site were significantly (1 percent and 5 percent level) higher than those produced on the control site.

TABLE 56. INFLUENCE OF SEWAGE EFFLUENT ON MEAN WEEKLY GROWTH (HEIGHT - CM) OF SNAP BEANS, 1976

Date	Control $\bar{X}$	Control ± SE	Treated $\bar{X}$	Treated ± SE
May 28, 1976	4.51	0.17	4.70	0.16
June 5, 1976	5.73	0.05	7.83**	0.26
June 15, 1976	8.88	0.38	11.65**	0.60
June 23, 1976	9.80	0.41	11.15**	0.48
June 29, 1976	9.00	0.31	9.53	0.43
July 8, 1976	14.28	0.44	12.78*	0.54
July 15, 1976	25.83	0.75	24.53	0.79
July 22, 1976	23.63	1.27	22.78	1.27

*, ** = Significantly different at 0.05 and 0.01 levels, respectively.

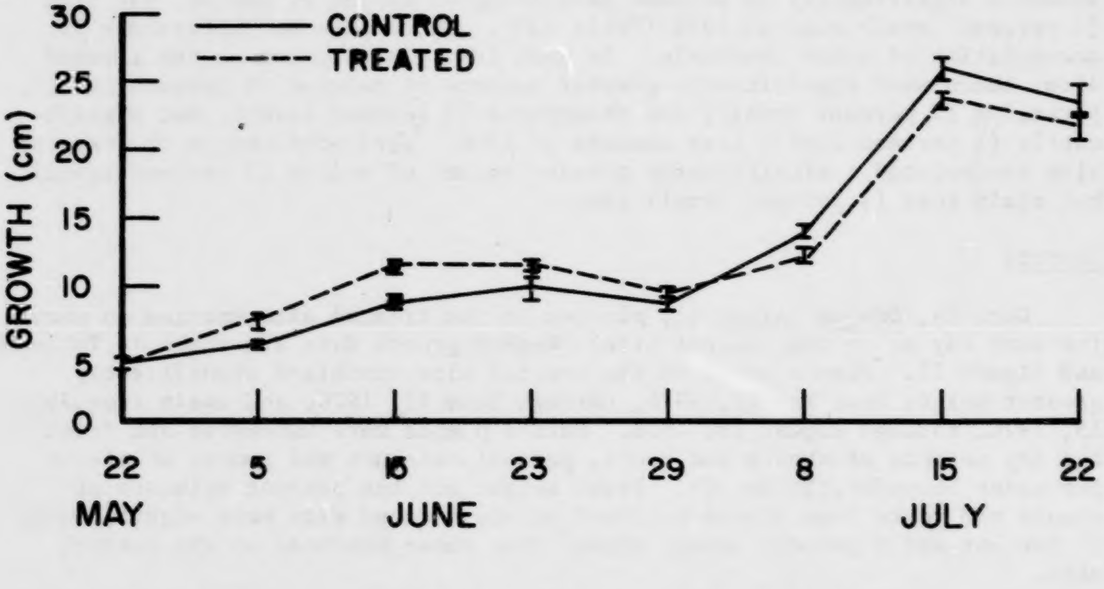


Figure 19. Influence of sewage effluent on snap bean growth, 1976.

TABLE 57. INFLUENCE OF SEWAGE EFFLUENT ON FRESH AND DRY WEIGHTS OF PLANTS, PODS, AND SEEDS OF SNAP BEANS (HARVESTED 1 METER OR ROW), 1976

Blocks	Fresh Weights (gms/m)			Dry Weights (gms/m)					
	Plant	Pod	Seed	Plant	% Moist	Pod	% Moist	Seed	% Moist
				Control					
I	1317.30	143.20	13.90	174.88	87	12.15	92	2.35	83
II	1269.10	1050.80	85.40	172.24	86	66.78	94	11.33	87
III	1017.24	652.89	63.72	191.27	81	91.88	86	13.81	78
IV	812.84	219.09	35.34	136.73	83	27.58	87	7.53	79
$\overline{X}$	1104.12	516.50	49.59	168.78	84	49.60	90	8.76	82
				Treated					
I	1366.42	380.60	52.50	177.05	87	32.26	92	9.75	81
II	1314.53	237.31	11.01	182.10	86	19.80	92	1.02	91
III	1859.58	100.87	19.07	255.74	86	13.18	87	4.11	78
IV	1712.67	67.03	8.85	226.71	87	7.24	89	1.42	84
$\overline{X}$	1563.30	196.45	22.86	210.40	86	18.12	90	4.08	83
	NS	NS	NS	NS	NS	NS		NS	NS

NS = Not significantly different.

In 1977, the variation in carrot plant height was sporadic with plants growing on the treated site being significantly higher (1 percent level) than those of the control site early in the season (Table 71 and Figure 22). By July 12, however, there was no significant difference in their height. One week prior to harvest the plants on the control site were significantly (5 percent level) higher than those on the treated site. On a fresh weight basis the plants grown on the control site produced significantly (5 percent level) more shoot and root growth than did those on the treated site (Table 72). Although the dry weight of the shoots produced on the two sites were not significant, the dry weights of the roots produced on the control site were significantly (1 percent level) greater than those produced on the treated site. There was no significant difference in the R/S ratios of the fresh and dry weights between the two plots in either year (Table 73). Combined analysis of carrot shoot and root fresh weights for 1976 and 1977 showed only a significant (1 percent level) interaction between year and treatment (Tables 74 and 75). Similar analysis for shoot dry weights for both years exhibited a significant (5 percent level) difference due to year (Table 76). The combined root dry weight data for 1976 and 1977, however, showed a significant interaction (5 percent level) between year and treatment (Table 77). Examination of the combined R/S ratios for 1976 and 1977 shows a significant (1 percent level) difference due to year (Table 78).

TABLE 58. INFLUENCE OF SEWAGE EFFLUENT ON YIELD COMPONENTS—NUMBER OF PODS PER PLANT, SEEDS PER POD, AND AVERAGE SEED WT (GMS)—AND SEED PER METER OF BEANS, 1976

Blocks	Control				Treated			
	Pods/ Plant	Seeds/ Pod	Average Seed Wt. (gms/m)	Seeds/ Meter	Pods/ Plant	Seeds/ Pod	Average Seed Wt. (gms/m)	Seeds/ Meter
I	3.5	2.9	0.23	10.2	11.9	5.2	0.16	61.9
II	17.1	4.5	0.15	77.0	6.0	3.8	0.04	22.8
III	19.9	3.6	0.19	71.6	2.3	4.6	0.39	10.6
IV	5.8	4.1	0.32	23.8	2.0	3.6	0.20	7.2
$\bar{X}$	11.6	3.8	0.22	45.6	5.6	4.3	0.20	25.6
	**	NS	NS	NS	**	NS	NS	NS

** = Significant at $P < 0.01$ level.
NS = Not significantly different.

Chemical analysis of the tops (shoots) indicated significantly higher amounts of phosphorus (5 percent level) and sodium (1 percent level) but less zinc (1 percent level) accumulated in plants produced on the treated site (Table 133). Significantly (1 percent level) greater quantities of potassium and sodium, but lesser quantities of copper (5 percent level) and zinc (1 percent level) were recorded in the edible roots produced on the treated site.

Corn

Corn, Zea mays L., planted on the treated site emerged on about the same day as on the control site in 1976. Weekly growth data are shown in Table 79 and Figure 23. Growth of the corn plants on the treated site were significantly (1 percent level) greater throughout the season than those growing on the control site. When the growth data of Table 79 are plotted as a function of time (Figure 23), the standard growth curve is clearly evident (i.e., a rather slow increase initially, followed by a rapidly increasing growth rate as photosynthesis becomes established in the new leaves, and then a decrease in growth rate as the plants approach maturity).

Although plants growing on the treated site exhibited greater fresh and dry weights, these differences were not significantly different (Table 80). However, there were significant (1 percent level) differences in the fresh and dry weights and percent moisture of the ears produced.

In corn, the components of yield are the average number of plants per row length, number of ears per row length, the average number of rows of kernels per ear, average number of kernels per row on the ear, and average seed size (weight). There was no significant difference in number of plants per meter,

TABLE 59. INFLUENCE OF SEWAGE EFFLUENT ON MEAN WEEKLY GROWTH (HEIGHT - CM) OF SNAP BEANS, 1977

Date	Control		Treated	
	$\overline{X}$	± SE	$\overline{X}$	± SE
June 1, 1977	5.95	0.45	1.70**	0.26
June 8, 1977	5.85	0.33	6.00 NS	0.49
June 14, 1977	6.36	0.35	7.78**	0.19
June 21, 1977	7.87	0.32	9.09*	0.45
June 28, 1977	12.77	0.74	10.91*	0.47
July 5, 1977	12.45	0.43	12.86 NS	0.75
July 12, 1977	13.53	0.62	15.37 NS	0.73
July 22, 1977	15.25	0.66	18.79**	0.88
July 29, 1977	20.05	0.67	20.33 NS	0.71
August 5, 1977	23.33	0.65	25.23 NS	1.11
August 12, 1977	27.88	0.55	25.33*	1.20

*, ** = Significantly different at the 0.05 and 0.01 levels, respectively.
NS = Not significantly different.

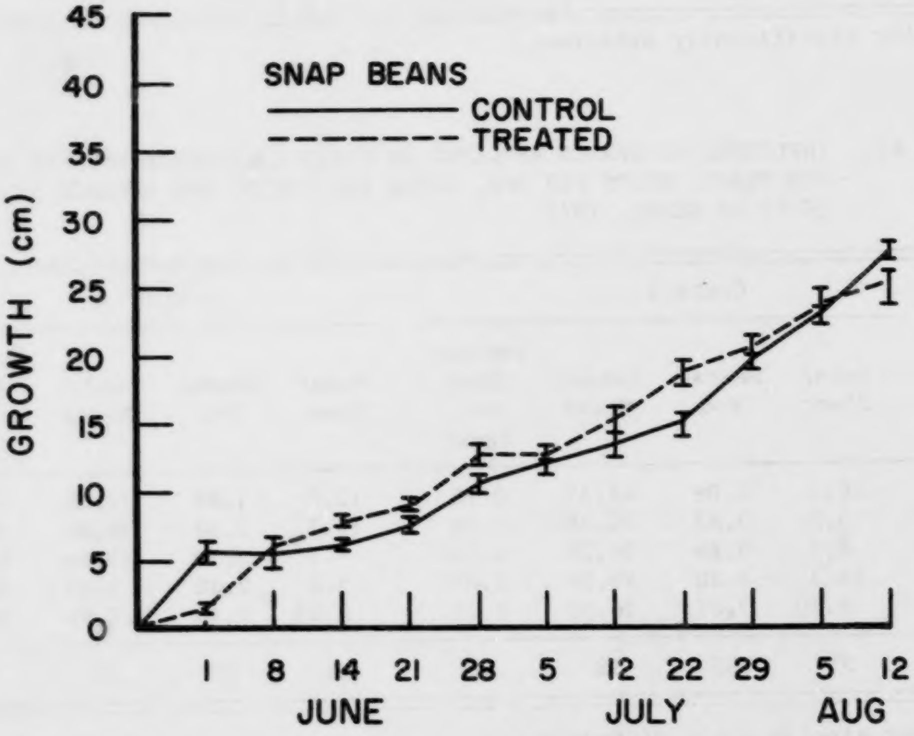


Figure 20. Influence of sewage effluent on snap bean growth, 1977.

TABLE 60. INFLUENCE OF SEWAGE EFFLUENT ON FRESH AND DRY WEIGHTS OF BEAN PLANTS, PODS, AND SEEDS--HARVESTED 1 METER OF ROW, 1977

Blocks	Control					
	Fresh Weights (gms/m)			Dry Weights (gms/m)		
	Plant	Pod	Seed	Plant	Pod	Seed
I	707.60	165.50	541.10	64.10	57.50	6.60
II	314.60	28.90	285.70	46.30	12.30	34.00
III	376.30	116.10	360.20	41.10	60.50	19.40
IV	724.80	62.80	662.00	84.50	35.50	49.60
$\overline{X}$	555.83	93.33	462.25	59.00	41.45	27.25
	Treated					
I	125.00	8.60	116.40	22.30	7.70	14.60
II	146.80	5.20	141.60	23.40	4.90	18.50
III	611.10	76.70	534.40	83.50	44.20	39.30
IV	337.10	22.90	314.10	52.70	19.10	33.60
$\overline{X}$	305.00	28.35	276.63	45.48	18.98	26.50
	NS	NS	NS	NS	NS	NS

NS = Not significantly different.

TABLE 61. INFLUENCE OF SEWAGE EFFLUENT ON YIELD COMPONENTS--NUMBER OF PODS PER PLANT, SEEDS PER POD, SEEDS PER METER, AND AVERAGE SEED WT (GMS) OF BEANS, 1977

Blocks	Control				Treated			
	Pods/ Plant	Seeds/ Pod	Seeds/ Meter	Average Seed Wt. (gms)	Pods/ Plant	Seeds/ Pod	Seeds/ Meter	Average Seed Wt. (gms)
I	10.2	4.86	49.57	0.10	12.0	1.88	22.56	0.08
II	5.6	3.67	20.55	0.18	15.2	2.57	39.06	0.07
III	8.1	3.24	26.24	0.12	7.3	3.19	23.29	0.14
IV	15.3	3.20	48.96	0.07	3.2	2.20	7.04	0.31
$\overline{X}$	9.80	3.87	36.33	0.12	9 43	2.46	22.99	0.15
	NS	NS	NS	NS	NS	NS	NS	NS

NS = Not significantly different.

TABLE 62. COMBINED ANALYSIS OF FRESH WEIGHTS OF BEAN PLANTS FOR 1976 AND 1977

Source	DF	SS	MS	F
Replications (R) Within Years	6	161,688.82	26,948.14	<1.00
Year (Y)	1	3,263,785.49	3,263,785.49	40.60**
Treatment (T)	1	43,411.81	43,411.81	<1.00
Y x T	1	504,107.10	504,107.10	6.27*
R x T	6	482,365.74	80,394.29	
Total	15	4,455,358.96	---	
Correction Factor	1	12,448,512.78	---	
Uncorrected Total	16	16,903,871.74		

*, ** = Significantly different at the 0.05 and 0.01 levels, respectively.

TABLE 63. COMBINED ANALYSIS OF DRY WEIGHTS OF BEAN PLANTS FOR 1976 AND 1977

Source	DF	SS	MS	F
Replications (R) Within Years	6	4,610.10	768.35	<1.00
Year (Y)	1	75,467.67	75,467.67	92.65**
Treatment (T)	1	1,000.00	1,000.00	1.23 NS
Y x T	1	2,830.30	2,830.30	3.47 NS
R x T	6	4,887.38	814.56	
Total	15	88,795.45	---	
Correction Factor	1	233,917.32	---	
Uncorrected Total	16	312,712.77		

** = Significantly different at the 0.01 level.

TABLE 64. COMBINED ANALYSIS OF BEAN POD FRESH WEIGHTS FOR 1976 AND 1977

Source	DF	SS	MS	F
Replications (R) Within Years	6	283,603.38	47,267.23	1.00
Year (Y)	1	349,603.17	349,603.17	6.48*
Treatment (T)	1	148,238.47	148,238.47	2.75 NS
Y x T	1	65,059.43	65,059.43	1.2 NS
R x T	6	323,850.47	53,975.08	
Total	15	1,170,354.92	---	
Correction Factor	1	696,594.72	---	
Uncorrected Total	16	2,046,949.64		

* = Significantly different at the 0.05 level.
NS = Not significantly different.

TABLE 65. COMBINED ANALYSIS OF BEAN POD DRY WEIGHTS FOR 1976 AND 1977

Source	DF	SS	MS	F
Replications (R) Within Years	6	3,630.57	605.10	1.15 NS
Year (Y)	1	53.18	53.18	<1.00
Treatment (T)	1	2,910.87	2,910.87	5.54 NS
Y x T	1	81.05	81.05	<1.00
R x T	6	3,152.28	525.38	
Total	15	9,827.95	---	
Correction Factor	1	16,420.50	---	
Uncorrected Total	16	26,248.45		

NS = Not significantly different.

TABLE 66. COMBINED ANALYSIS OF BEAN SEED FRESH WEIGHT FOR 1976 AND 1977

Source	DF	SS	MS	F
Replications (R) Within Years	6	92,871.54	15,478.59	<1.00
Year (Y)	1	444,125.61	444,125.61	24.06**
Treatment (T)	1	45,095.71	45,095.71	2.44 NS
Y x T	1	25,246.82	25,246.82	1.37 NS
R x T	6	110,774.53	18,462.42	
Total	15	718,114.21	---	
Correction Factor	1	658,244.20	---	
Uncorrected Total	16	1,376,358.41		

** = Significantly different at the 0.01 level.
NS = Not significantly different.

TABLE 67. COMBINED ANALYSIS OF BEAN SEED DRY WEIGHT FOR 1976 AND 1977

Source	DF	SS	MS	F
Replications (R) Within Years	6	979.81	163.30	1.72 NS
Year (Y)	1	1,674.45	1,674.45	17.62**
Treatment (T)	1	29.48	29.48	<1.00
Y x T	1	15.45	15.45	<1.00
R x T	6	570.03	95.01	
Total	15	3,269.21	---	
Correction Factor	1	4,432.90	---	
Uncorrected Total	16	7,702.11		

** = Significantly different at the 0.01 level.
NS = Not significantly different.

TABLE 68. COMBINED ANALYSIS OF BEAN SEEDS PER POD FOR 1976 AND 1977

Source	DF	SS	MS	F
Replications (R) Within Years	6	0.81	0.14	<1.00
Year (Y)	1	3.05	3.05	3.91 NS
Treatment (T)	1	0.78	0.78	<1.00
Y x T	1	3.73	3.73	4.78 NS
R x T	6	4.70	0.78	
Total	15	13.07	--	
Correction Factor	1	207.43	--	
Uncorrected Total	16	220.50		

NS = Not significantly different.

ears per meter or kernels per row on the ear (Table 81). However, there was a significantly (5 percent level) higher number of rows of kernels per ear on ears produced on the control site.

In 1977, corn planted on the treated site emerged on about the same day as on the control site. However, weekly growth data, shown in Table 82 and Figure 24, indicated greater plant heights in plants grown on the treated site than on the control site from the first week of measurement until the last two weeks prior to harvest. Only the plant dry weights on the treated site were significantly (5 percent level) higher than those on the control site (Table 83). No differences were observed in the components of yield for corn grown on the two sites (Table 84).

Combined analysis of corn plant fresh weights for 1976 and 1977 showed only a significant (5 percent level) difference due to treatment (Table 85). However, when examining the combined dry weight data significant (1 percent level) differences were observed for year and treatment (Table 86). Combined corn ear fresh and dry weight data for 1976 and 1977 exhibited only a significant (1 percent level) variation due to treatment (Tables 87 and 88). Examining the components of yield, namely, corn ears per meter for 1976 and 1977, significant (1 percent level) difference was observed due to year (Table 89). Combined analysis of corn kernel rows per ear showed a highly significant (1 percent level) difference due to year and a highly significant (1 percent level) interaction of year times treatment (Table 90).

Chemical analysis of corn plants showed significantly greater amounts of potassium (1 percent level), sodium (5 percent level), and zinc (1 percent level) in the plants grown on the control site than in those on the treated site (Table 133). When seeds were analyzed, those produced on the control site had significantly higher amounts of nitrogen (1 percent level), copper (5 percent level), and zinc (1 percent level). Only zinc was significantly (5 percent level) higher in the cobs from plants grown on the control site.

TABLE 69. INFLUENCE OF SEWAGE EFFLUENT ON MEAN WEEKLY GROWTH (HEIGHT - CM) OF CARROTS, 1976

Date	Control			Treated		
	$\bar{X}$	±	SE	$\bar{X}$	±	SE
May 22, 1976	0.73		0.07	0.90**		0.003
May 28, 1976	2.94		0.16	3.89**		0.19
June 5, 1976	6.70		0.24	8.28**		0.36
June 15, 1976	10.35		0.28	14.03**		0.42
June 23, 1976	15.23		0.65	18.88**		0.46
June 29, 1976	18.60		0.51	20.35 NS		1.07
July 8, 1976	22.95		0.59	24.18 NS		1.29
July 15, 1976	25.53		0.76	32.98**		0.95
July 22, 1976	30.78		0.59	39.05**		0.92
July 29, 1976	30.70		1.11	39.85**		0.99
August 5, 1976	29.60		1.04	41.78**		1.05
August 12, 1976	29.03		0.25	41.39**		1.41
August 19, 1976	31.98		0.81	44.88**		1.30

** = Significantly different at 0.01 level.
NS = Not significantly different.

Lettuce

Lettuce, *Lactuca sativa* L., planted on the treated site emerged at about the same time as did those on the control site in 1976. Weekly growth data are shown in Table 91 and Figure 25. The growth curve is largely linear, but the plants on the treated site did level off near the end as the plants approached maturity somewhat earlier than did those on the control site. Plant growth, as measured by plant height, was significantly (1 percent level) greater in those plants growing on the treated site throughout the season. Entire plants were harvested and fresh and dry weights and percent moisture recorded (Table 92). Fresh weight of plants on the treated site was significantly (1 percent level) higher than the plants from the control site.

In 1977, lettuce planted on the treated site emerged three weeks before the plants on the control site (Table 94 and Figure 26). With the three weeks additional growth, the plants on the treated site were significantly (1 percent level) higher than those on the control site. Moreover, the fresh and dry weights of plants grown on the treated site were significantly (5 percent level) higher than those on the control, and contained significantly (1 percent level) less moisture (Table 94).

Combined analysis of lettuce fresh weight for 1976 and 1977 showed significant (1 percent level) differences due to year and also to treatment (Table 95), whereas dry weight data exhibited only a significant (5 percent level) difference due to treatment (Table 96).

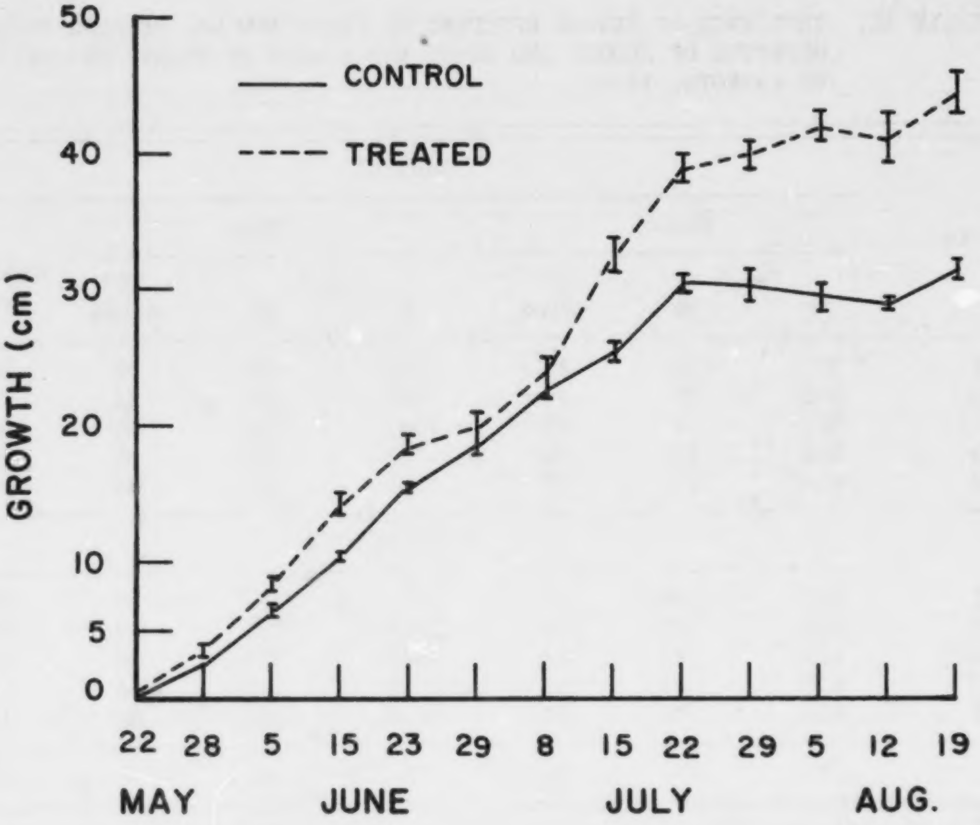


Figure 21. Influence of sewage effluents on carrot growth, 1976.

Chemical analysis indicated lettuce plants from the control site were significantly (5 percent level) higher in copper and zinc, whereas those growing on the treated site were significantly (1 percent level) higher in phosphorus and sodium (Table 133).

Onion

Onions, Allium cepa L., planted on the treated site emerged about the same time as did those on the control site in 1976. The weekly growth data are shown in Table 97 and Figure 27. After two weeks, the growth, as measured by plant height, of the plants on the treated site was significantly (1 percent level) different throughout the season. As seen in Figure 27, this growth was linear with time for both sites. Interestingly, although the treated site produced a greater amount of fresh and dry weight of material, these differences were not significant (Table 98). The control plots, however, did have a significantly (1 percent level) higher number of plants per meter.

TABLE 70. INFLUENCE OF SEWAGE EFFLUENT ON FRESH AND DRY WEIGHTS PERCENT MOISTURE OF SHOOTS AND ROOTS AND NUMBER OF PLANTS PER METER OF CARROTS, 1976

Blocks	Control						
	Shoot			Root			Plants/ Meter
	(gms) FW	DW	% Moist	(gms) FW	DW	% Moist	
I	353	59	83	1059	186	82	29
II	500	79	84	1603	244	85	27
III	362	54	85	1083	149	86	20
IV	582	83	86	1710	236	86	29
$\overline{X}$	450	69	85	1364	203	85	26
	Treated						
I	845	108	87	2045	252	88	22
II	584	80	86	2208	251	89	13
III	695	92	87	2688	324	88	24
IV	618	83	87	1982	243	88	17
$\overline{X}$	686	91	87	2230	268	88	19
	*	NS	*	**	NS	*	NS

*,** = Significant difference at the 0.05 and 0.01 levels, respectively.
NS = Not significantly different.

Chemical analysis of the tops and bulbs of the onions grown on the control site indicated significantly (1 percent level) higher amounts of nitrogen (Table 133). Bulbs of the onions grown on the treated site exhibited significantly higher amounts of iron (1 percent level), sodium (5 percent level), and zinc (1 percent level).

Peas

Peas, Pisum sativum L., planted on the treated site emerged on the same day as those planted on the control site in 1976. Weekly growth data, measured to the nearest centimeter, are shown in Table 99 and Figure 28. During the first three weeks there were no significant differences in the rate of growth of peas on the two sites. Beginning on May 28, 1976, the growth rate of peas on the treated site was significantly (1 percent level) greater than those on the control site. This significant difference remained through harvest.

Entire plants were harvested at ground surface level and fresh and dry weights of plants, pods, and seeds recorded (Table 100). There was no

TABLE 71. INFLUENCE OF SEWAGE EFFLUENT ON MEAN WEEKLY GROWTH (HEIGHT - CM) OF CARROTS, 1977

Date	Control		Treated	
	$\overline{X}$	± SE	$\overline{X}$	± SE
June 8, 1977	2.65	0.11	3.55**	0.17
June 14, 1977	3.30	0.14	4.65**	0.24
June 21, 1977	5.43	0.23	9.23**	0.51
June 28, 1977	9.48	0.34	14.90**	0.76
July 5, 1977	14.58	0.60	17.83*	0.96
July 12, 1977	13.70	0.80	16.80 NS	1.00
July 22, 1977	17.78	1.90	22.03 NS	1.36
July 29, 1977	24.58	1.15	23.93 NS	1.36
August 4, 1977	28.05	0.79	27.00 NS	1.07
August 12, 1977	31.15	1.00	28.23 NS	1.39
August 19, 1977	34.28	0.83	33.17 NS	1.23
August 26, 1977	36.85	0.98	31.07*	1.28

*, ** = Significantly different at the 0.05 and 0.01 levels, respectively.
NS = Not significantly different.

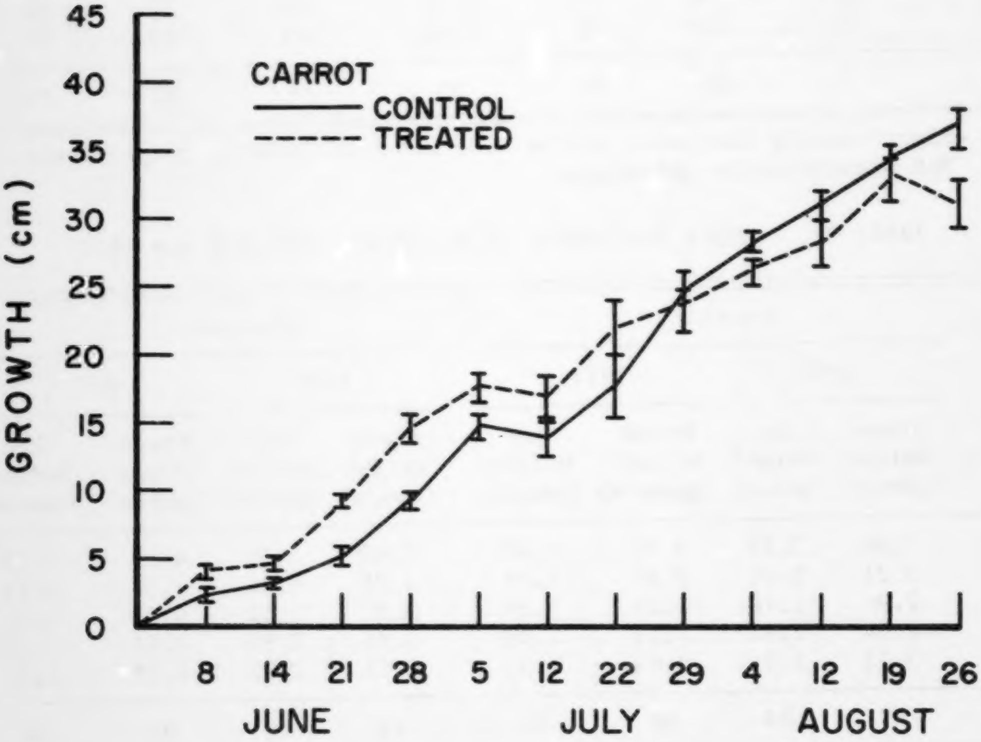


Figure 22. Influence of sewage effluent on carrot growth, 1977.

TABLE 72. INFLUENCE OF SEWAGE EFFLUENT ON FRESH AND DRY WEIGHTS, PERCENT MOISTURE OF SHOOTS AND ROOTS, AND NUMBER OF PLANTS PER METER OF CARROTS, 1977

Blocks	Control						
	Shoots			Roots			
	Fresh Weight (Grams/ Meter)	Dry Weight (Grams/ Meter)	% Moisture	Fresh Weight (Grams/ Meter)	Dry Weight (Grams/ Meter)	% Moisture	Plants/ Meter
I	663	128	81	2348	216	90	23
II	1244	185	85	3596	295	92	103
III	581	227	61	2929	202	93	11
IV	565	104	82	2346	208	91	26
X̄	763	161	80	2805	230	92	41
	Treated						
I	385	120	69	1769	154	91	36
II	620	229	63	2711	255	91	57
III	254	63	75	1026	72	93	34
IV	280	68	76	1570	135	91	16
X̄	385	120	71	1769	154	92	36
	*	NS	NS	*	**	NS	NS

*,** = Significantly different at the 0.05 and 0.01 levels, respectively.
NS = Not significantly different.

TABLE 73. CARROT ROOT/SHOOT (R/S) RATIOS FOR 1976 and 1977

Blocks	Control				Treated			
	1976		1977		1976		1977	
	Fresh Weight (gms/m)	Dry Weight (gms/m)	Fresh Weight (gnms/m)	Dry Weight (gms/m)	Fresh Weight (gms/m)	Dry Weight (gms/m)	Fresh Weight (gms/m)	Dry Weight (gms/m)
I	3.00	3.15	3.54	1.69	2.42	2.33	4.59	1.28
II	3.21	3.09	2.89	1.59	3.78	3.14	4.37	1.11
III	2.99	2.76	5.04	0.89	3.87	3.52	4.04	1.14
IV	2.94	2.84	4.15	2.00	3.21	2.93	5.61	1.99
X̄	3.03	2.94	3.68	1.43	3.25	2.95	4.59	1.28
	NS	NS	NS	NS	NS	NS	NS	NS

NS = Not significantly different.

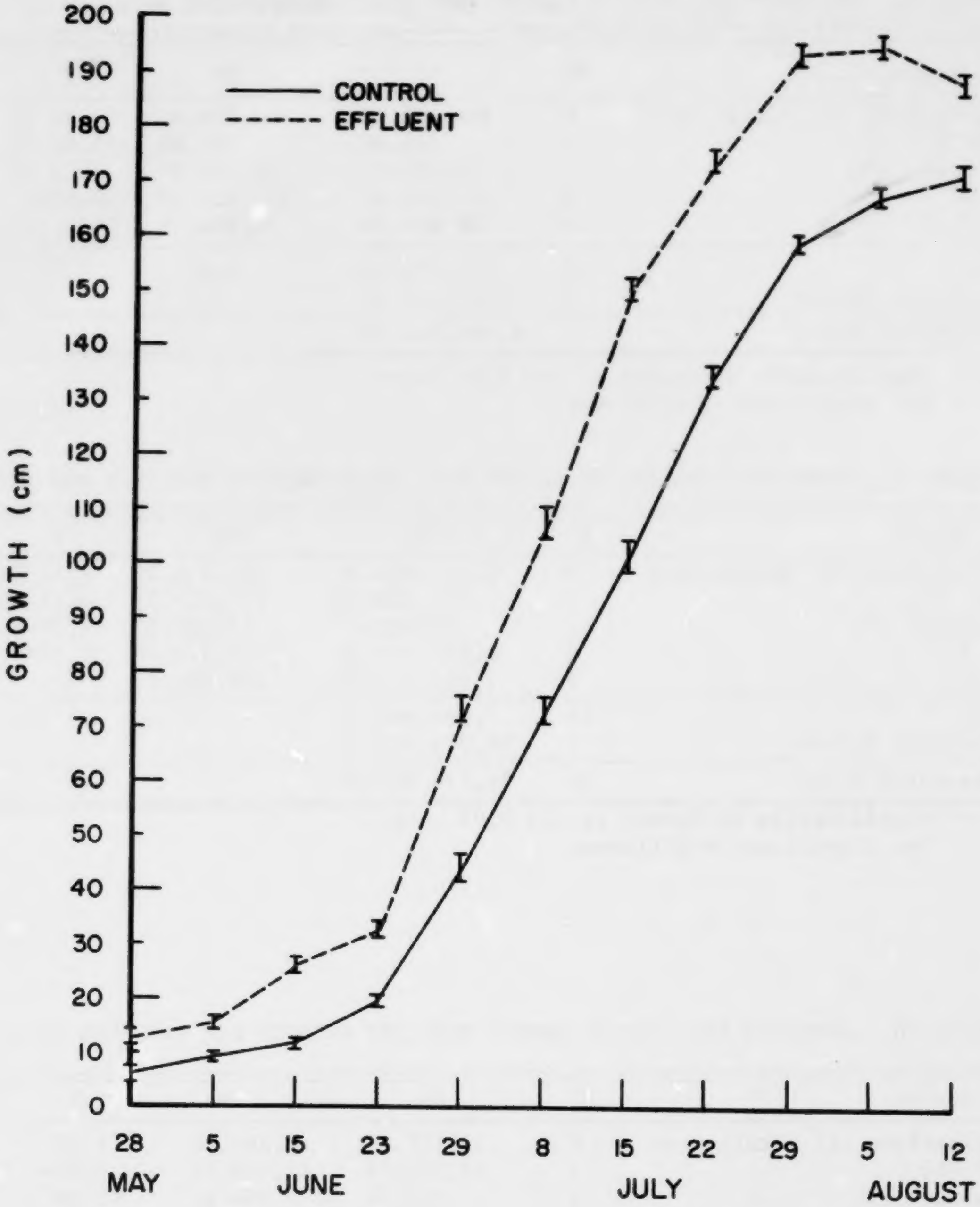


Figure 23. Influence of sewage effluent on the growth of corn, 1976.

TABLE 74. COMBINED ANALYSIS OF CARROT TOPS FRESH WEIGHTS FOR 1976 AND 1977

Source	DF	SS	MS	F
Replications (R) Within Year	6	364,200.35	60,700.06	3.32 NS
Year (Y)	1	166.86	166.86	<1.00 NS
Treatment (T)	1	20,329.77	20,329.77	1.11 NS
Y x T	1	377,711.65	377,711.65	20.63**
R x T	6	109,827.39	18,304.57	
Total	15	872,236.02	---	
Correction Factor	1	5,211,712.31	---	
Uncorrected Total	16	6,083,948.33		

** = Significantly different at the 0.01 level.
NS = Not significantly different.

TABLE 75. COMBINED ANALYSIS OF CARROT ROOT FRESH WEIGHTS FOR 1976 AND 1977

Source	DF	SS	MS	F
Replications (R) Within Year	6	2,178,081.36	363,013.56	2.14 NS
Year (Y)	1	957,300.78	957,300.78	5.65 NS
Treatment (T)	1	28,588.87	28,588.87	<1.00 NS
Y x T	1	3,619,820.20	3,619,820.20	21.37**
R x T	6	1,016,176.98	169,362.83	
Total	15	7,799,968.18	---	
Correction Factor	1	66,714,876.31	---	
Uncorrected Total	16	74,514,844.49		

** = Significantly different at the 0.01 level.
NS = Not significantly different.

TABLE 76. COMBINED ANALYSIS OF CARROT TOPS DRY WEIGHTS FOR 1976 AND 1977

Source	DF	SS	MS	F
Replications (R) Within Year	6	15,577.09	2,596.18	1.22
Year (Y)	1	14,598.68	14,598.68	6.88*
Treatment (T)	1	358.16	358.16	<1.00
Y x T	1	3,959.55	3,959.55	1.87
R x T	6	12,736.32	2,122.72	
Total	15	47,229.80	---	
Correction Factor	1	193,446.03	---	
Uncorrected Total	16	240,675.83		

* = Significantly different at the 0.05 level.

TABLE 77. COMBINED ANALYSIS OF CARROT ROOT DRY WEIGHTS FOR 1976 AND 1977

Source	DF	SS	MS	F
Replications (R) Within Year	6	21,552.28	3,592.05	1.84
Year (Y)	1	7,532.94	7,532.94	3.86
Treatment (T)	1	152.34	152.34	<1.00
Y x T	1	19,696.01	19,696.01	10.09*
R x T	6	11,708.43	1,951.41	
Total	15	60,642.00	---	
Correction Factor	1	731,379.87	---	
Uncorrected Total	16	792,021.87		

* = Significantly different at the 0.05 level.

TABLE 78. COMBINED ANALYSIS OF DRY WEIGHTS OF CARROT ROOT/SHOOT (R/S) RATIOS FOR 1976 AND 1977

Source	DF	SS	MS	F
Replications (R) Within Year	6	1.26	0.21	1.50
Year (Y)	1	8.92	8.92	63.71**
Treatment (T)	1	0.02	0.02	<1.00
Y x T	1	0.02	0.02	<1.00
R x T	6	0.86	0.14	
Total	15	11.07	--	
Correction Factor	1	78.94	--	
Uncorrected Total	16	90.01		

** = Significantly different at the 0.01 level.

TABLE 79. INFLUENCE OF SEWAGE EFFLUENT ON THE MEAN WEEKLY GROWTH (CM) OF CORN, 1976

Date	Control		Treated	
	$\overline{X}$	± SE	$\overline{X}$	± SE
May 28, 1976	5.89	0.50	12.89**	0.68
June 5, 1976	9.51	0.52	16.23**	0.70
June 15, 1976	11.68	0.38	26.43**	0.98
June 23, 1976	19.78	0.77	33.00**	0.72
June 29, 1976	44.05	1.54	73.83**	2.01
July 8, 1976	73.65	1.44	107.60**	2.52
July 15, 1976	101.80	1.69	150.65**	1.85
July 22, 1976	135.20	1.45	175.00**	1.77
July 29, 1976	159.28	1.57	194.33**	1.79
August 5, 1976	168.38	1.37	196.05**	1.80
August 12, 1976	171.50	1.68	189.68**	1.86

** = Significantly different at the 0.01 level.

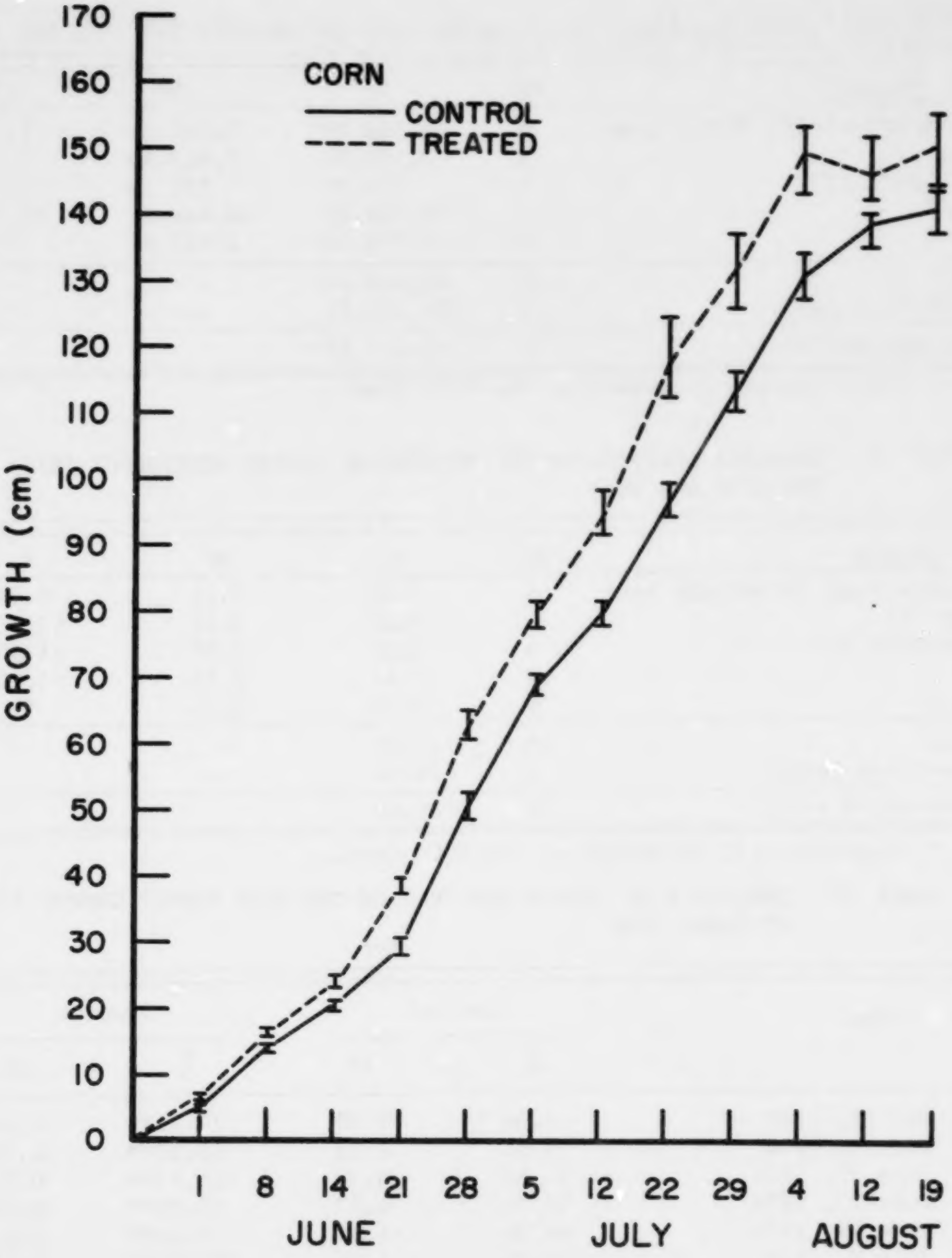


Figure 24. Influence of sewage effluent on the growth of corn, 1977.

TABLE 80. INFLUENCE OF SEWAGE EFFLUENT ON FRESH AND DRY WEIGHTS OF CORN PLANTS AND EARS AND PERCENT MOISTURE, 1976

Block	Control					
	Plants			Ears		
	(gms/m) FW	DW	% Moist	(gms/m) FW	DW	% Moist
I	1689	430	75	312	44	86
II	2797	645	77	942	165	82
III	2308	585	75	690	120	83
IV	1962	457	77	438	54	88
$\bar{X}$	2189	529	76	596	96	85
	Treated					
I	2742	770	72	1593	387	76
II	3124	767	75	1940	520	73
III	2151	549	74	949	232	87
IV	2667	604	77	667	85	87
$\bar{X}$	2671	673	75	1287*	306*	78*

* = Significantly different at 0.05 level.

TABLE 81. INFLUENCE OF SEWAGE EFFLUENT ON COMPONENTS OF YIELD IN CORN, NUMBER OF PLANTS/METER, EARS/METER, ROWS OF KERNELS/EAR, AND KERNELS/ROW, 1976

Blocks	Control				Treated			
	Plants/ Meter	Ears/ Meter	Row of Kernels/ Ear	Kernels/ Row of Ear	Plants/ Meter	Ears/ Meter	Row of Kernels/ Ear	Kernels/ Row of Ear
I	6	7	16	40	11	11	13	35
II	13	8	16	39	11	9	12	39
III	11	10	14	35	12	10	12	41
IV	9	9	13	37	11	6	12	36
$\bar{X}$	10	9	15	38	11	9	12	38
	NS	NS	*	NS	NS	NS	*	NS

* = Significantly different at 0.05 level.
NS = Not significantly different.

TABLE 82. INFLUENCE OF SEWAGE EFFLUENT ON THE MEAN WEEKLY GROWTH (HEIGHT - CM) OF CORN, 1977

Date	Control			Treated		
	$\overline{X}$	±	SE	$\overline{X}$	±	SE
June 1, 1977	5.08		0.22	6.64**		0.32
June 8, 1977	14.30		0.44	16.85**		0.63
June 14, 1977	20.75		0.49	24.10**		0.54
June 21, 1977	29.43		1.00	39.18**		1.04
June 28, 1977	63.13		2.08	51.23**		1.89
July 5, 1977	69.33		1.65	80.05**		2.28
July 12, 1977	81.68		1.88	95.23**		3.71
July 22, 1977	97.43		2.37	118.80**		5.41
July 29, 1977	114.03		2.59	132.95**		5.63
August 4, 1977	131.25		3.50	149.55**		5.61
August 12, 1977	139.45		2.99	146.83 NS		5.38
August 19, 1977	141.43		2.54	150.85 NS		5.82

** = Significantly different at the 0.01 level.
NS = Not significantly different.

TABLE 83. INFLUENCE OF SEWAGE EFFLUENT ON FRESH AND DRY WEIGHTS OF CORN PLANTS AND EARS AND PERCENT OF MOISTURE, 1977

Block	Control					
	Plants			Ears		
	(grams/meter) Fresh Weight	Dry Weight	% Moisture	(grams/meter) Fresh Weight	Dry Weight	% Moisture
I	3973	1480	63	1355	235	83
II	2011	560	72	1040	242	77
III	1728	530	69	614	123	80
IV	1862	390	79	547	134	76
$\overline{X}$	2394	740	71	889	183	79
	Treated					
I	6458	2140	67	2490	730	71
II	3478	1330	62	960	255	73
III	3928	1270	68	1695	451	73
IV	1758	450	74	380	72	81
$\overline{X}$	3906	1298	68	1381	377	75
	NS	*	NS	NS	NS	NS

* = Significantly different at the 0.05 level.
NS = Not significantly different.

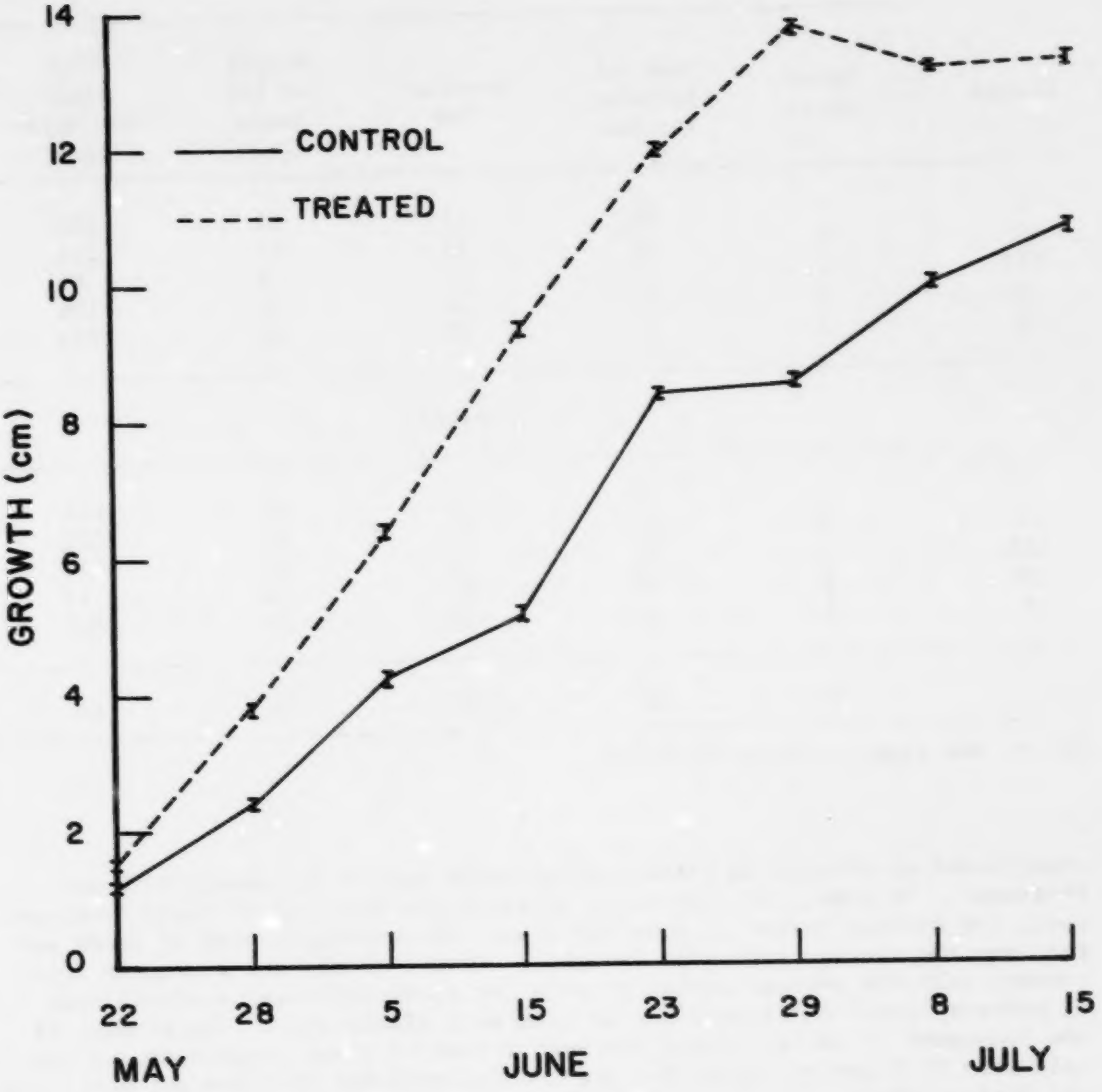


Figure 25. Influence of sewage effluent on the growth of lettuce, 1976.

TABLE 84. INFLUENCE OF SEWAGE EFFLUENT ON COMPONENTS OF YIELD IN CORN, NUMBER OF EARS PER METER, ROWS OF KERNELS PER EAR, KERNELS PER ROW, AND WEIGHT OF 100 SEEDS, 1977

Blocks	Ears/ Meter	Rows of Kernels Per Ear	Kernels/ Row	Weight of 100 Seeds (gms)	Seed Yield Per Meter (gms)
			Control		
I	7	14	33	12	388
II	5	15	31	11	256
III	4	13	33	5	86
IV	3	14	21	12	106
$\bar{X}$	5	14	29	10	203
			Treated		
I	7	17	35	16	666
II	3	18	34	11	202
III	5	16	41	14	459
IV	3	14	17	6	43
$\bar{X}$	5	16	32	12	307
	NS	NS	NS	NS	NS

NS = Not significantly different.

significant difference in these various parts due to the sewage effluent treatment. In peas, the components of yield are in order of their development, the average number of pods per plant, the average number of seeds per pod, and the average seed size (weight). When the data are viewed in this manner, only the average number of pods per plant exhibited a significant (1 percent level) difference due to treatment (Table 101). The product of the component is yield. Using the mean values of these components, we can calculate 21.9 gms per meter for the control site and 59.2 gms per meter for the treated site, or a 63 percent increase in the seed weight in plants grown on the treated site as compared to those on the control site.

Peas planted on the treated site in 1977 emerged on about the same day as those planted on the control site. Weekly growth data, measured to the nearest centimeter, are shown in Table 102 and Figure 29. Generally, there was no difference in the growth of the plants on the two sites. This general uniformity of growth was also expressed at harvest (Tables 103 and 104).

TABLE 85. COMBINED ANALYSIS OF CORN PLANT FRESH WEIGHTS FOR 1976 AND 1977

Source	DF	SS	MS	F
Replications (R) Within Year	6	13,421,969	2,236,994.83	5.54 NS
Year (Y)	1	2,070,721	2,070,721.00	5.13 NS
Treatment (T)	1	3,976,036	3,976,036.00	9.85*
Y x T	1	1,060,900	1,060,900.00	2.63 NS
R x T	6	2,420,835	403,472.50	
Total	15	22,950,461	---	
Correction Factor	1	124,523,281	---	
Uncorrected Total	16	147,473,742		

* = Significantly different at the 0.05 level.
NS = Not significantly different.

TABLE 86. COMBINED ANALYSIS OF CORN PLANT DRY WEIGHTS FOR 1976 AND 1977

Source	DF	SS	MS	F
Replications (R) Within Year	6	2,042,541.87	340,423.65	10.02
Year (Y)	1	698,478.07	698,478.07	20.55**
Treatment (T)	1	491,050.57	491,050.57	14.45**
Y x T	1	171,603.05	171,603.05	5.05
R x T	6	203,890.89	33,981.82	
Total	15	3,607,564.44	---	
Correction Factor	1	10,492,740.56	---	
Uncorrected Total	16	14,100,305.00		

** = Significantly different at the 0.01 level.

TABLE 87. COMBINED ANALYSIS OF CORN EAR FRESH WEIGHTS FOR 1976 AND 1977

Source	DF	SS	MS	F
Replications (R) Within Year	6	3,010,999.74	501,833.29	2.55
Year (Y)	1	150,156.26	150,156.26	1.00
Treatment (T)	1	1,401,856.00	1,401,856.00	7.12*
Y x T	1	39,800.00	39,800.00	< 1.00
R x T	6	1,182,124.77	197,020.80	
Total	15	5,784,937.00	---	
Correction Factor	1	17,247,409.00	---	
Uncorrected Total	16	23,032,346.00		

* = Significantly different at the 0.05 level.

TABLE 88. COMBINED ANALYSIS OF CORN EAR DRY WEIGHTS FOR 1976 AND 1977

Source	DF	SS	MS	F
Replications (R) Within Year	6	223,139.72	37,689.95	1.57
Year (Y)	1	25,074.73	25,074.73	1.05
Treatment (T)	1	163,296.81	163,296.81	6.82*
Y x T	1	268.96	268.96	<1.00
R x T	6	143,710.82	23,951.80	
Total	15	555,491.02	---	
Correction Factor	1	925,155.42	---	
Uncorrected Total	16	1,480,646.44		

* = Significantly different at the 0.05 level.

TABLE 89. COMBINED ANALYSIS OF CORN EARS PER METER FOR 1976 AND 1977

Source	DF	SS	MS	F
Replications (R) Within Year	6	24.37	4.06	1.76
Year (Y)	1	68.07	68.07	29.25**
Treatment (T)	1	0.07	0.07	<1.00
Y x T	1	1.05	1.05	<1.00
R x T	6	13.88	2.31	
Total	15	107.44	--	
Correction Factor	1	715.56	--	
Uncorrected Total	16	823.00		

** = Significantly different at the 0.01 level.

TABLE 90. COMBINED ANALYSIS OF CORN KERNEL ROWS PER EAR FOR 1976 AND 1977

Source	DF	SS	MS	F
Replications (R) Within Year	6	12.64	2.11	1.79
Year (Y)	1	11.80	11.80	10.00**
Treatment (T)	1	0.07	0.07	<1.00
Y x T	1	22.38	22.38	18.97**
R x T	6	7.08	1.18	
Total	15	53.97	---	
Correction Factor	1	3,298.78	---	
Uncorrected Total	16	3,352.75		

** = Significantly different at the 0.01 level.

TABLE 91. INFLUENCE OF SEWAGE EFFLUENT ON MEAN WEEKLY GROWTH (HEIGHT - CM) OF LETTUCE, 1976

Date	Control		Treated	
	$\overline{X}$	± SE	$\overline{X}$	± SE
May 22, 1976	1.21	0.06	1.51**	0.07
May 28, 1976	2.35	0.36	3.84**	0.18
June 5, 1976	4.30	0.20	6.40**	0.26
June 15, 1976	5.20	0.38	9.40**	0.46
June 23, 1976	8.45	0.30	12.03**	0.45
June 29, 1976	8.58	0.33	13.83**	0.48
July 8, 1976	10.08	0.34	13.15**	0.42
July 15, 1976	10.78	0.45	13.30**	0.37

** = Significantly different at 0.01 level.

Combined analysis of pea data for 1976 and 1977 likewise showed no significant difference due to treatment or year (Tables 105, 106, 107, 108, and 109). Examination of the yield components showed that only the average number of pea pods per plant showed a significant (1 percent level) variation due to year (Table 108).

Chemical analysis of the pea plants showed only significantly (1 percent level) greater amounts of potassium in the plants growing on the treated site, but significantly higher zinc in plants on the control site (Table 133). There was no significant difference in chemical composition within the pods or seeds produced on the two sites.

Potatoes

In 1976 potatoes, Solanum tuberosum L., planted on the treated site emerged on about the same day as on the control site. Weekly growth data are shown in Table 110 and Figure 30. Plants on the treated site were significantly (1 percent level) higher than those on the control site only on June 6, 1976, and June 15, 1976. There were no significant differences in the numbers of U.S. No. 1, 2, or 3 grade of potato tubers produced on the two sites (Table 111).

Chemical analysis of the plants showed significantly higher levels of copper (5 percent level) and zinc (1 percent level) in plants from the control site, but a significantly (1 percent level) greater accumulation of sodium from the treated site (Table 133). Significantly (1 percent level) higher amounts of sodium but less zinc accumulated in the tubers produced on the treated site as compared to the tubers from the control site.

TABLE 92. INFLUENCE OF SEWAGE EFFLUENT ON FRESH AND DRY WEIGHTS OF LETTUCE PLANTS (10 PLANTS PER REPLICATION PER TREATMENT), 1976

	Control			Treated		
Blocks	Fresh Weight (Grams/ Meter)	Dry Weight (Grams/ Meter)	Percent Moisture	Fresh Weight (Grams/ Meter)	Dry Weight (Grams/ Meter)	Percent Moisture
I	3119.41	96.20	97	4639.96	205.99	96
II	2148.77	72.07	97	5239.69	180.53	97
III	2276.09	66.61	97	4792.17	229.37	95
IV	1494.56	84.40	94	3368.71	129.27	96
$\bar{X}$	2259.71	79.82	96	4510.13	186.29	96
	**	NS	NS	**	NS	NS

** = Significantly different at 0.01 level.
NS = Not significantly different.

Radishes

In 1976 radishes, Brassica oleracea L., planted on the treated site emerged on the same day as those planted on the control Site. The weekly growth data, measured to the nearest centimeter, are shown in Table 112 and Figure 31. During the first three weeks there were no significant differences in the rate of growth of radishes on the two sites. After three weeks, beginning on May 29, 1976, the growth rate of radishes on the treated site was significantly (1 percent level) greater than those on the control site. However, by June 23, 1976, the growth of radish plants on the control site was essentially the same as on the treated site.

When the growth data of Table 112 are plotted as a function of time (Figure 31), we get the standard growth curve (i.e., a rather slow increase initially, followed by a rapidly increasing growth rate as photosynthesis becomes established in the new leaves). After six weeks of growth (marketable quality), entire plants were harvested and fresh and dry weights of shoots and roots recorded (Table 113). Interestingly, no significant differences were noted in either shoots or roots.

In 1977, radishes planted on the treated site emerged on about the same day as did those planted on the control site. Weekly growth data are shown in Table 114 and Figure 32. Initially, the radishes on the treated site grew faster and were significantly (1 percent level) higher than those on the control site. However, by harvest time there was no significant difference in the height of radish plants on the two sites. This is reflected in the fresh and dry weight and R/S ratio data (Table 115).

TABLE 93. INFLUENCE OF SEWAGE EFFLUENT ON MEAN WEEKLY GROWTH (HEIGHT - CM) OF LETTUCE, 1977

Date	Control			Treated		
	$\bar{X}$	±	SE	$\bar{X}$	±	SE
June 8, 1977	---		—	3.25		0.19
June 14, 1977	---		—	3.75		0.66
June 21, 1977	---		—	6.73		0.28
June 28, 1977	4.89		0.41	9.90**		0.38
July 5, 1977	6.29		0.39	13.10**		0.50
July 12, 1977	5.57		0.38	12.83**		0.70
July 22, 1977	8.07		0.42	14.40**		0.60

** = Significantly different at the 0.01 level.

Combined analysis of radish data for 1976 and 1977 showed significant (1 percent and 5 percent level) differences due to year (Tables 116, 117, 118, 119, 120, and 121).

Chemical analysis of radish tops grown on the control site had significantly higher amounts of calcium (1 percent level), potassium (1 percent level), nitrogen (5 percent level), iron (5 percent level), sodium (1 percent level), and zinc (1 percent level), whereas those grown on the treated site were significantly higher only in phosphorus (1 percent level) and sodium (5 percent level) (Table 133). The edible portion of radish, the root, exhibited significantly (1 percent level) higher amounts of nitrogen in the roots grown on the control site, but significantly higher quantities of phosphorus (1 percent level) and sodium (1 percent level) in roots from plants grown on the treated site.

Tomato

In 1976 tomato, Lycopersicon esculentum L., plants (12-15 cm) were transplanted to the field. The plants on the control site were significantly (1 percent level) larger than those on the treated site for the first two weeks (Table 118 and Figure 33). However, after June 29, 1976, those growing on the treated site were significantly (1 percent level) larger and remained so throughout the season.

Chemical analysis showed that tomato fruits produced on the control site had significantly higher amounts of nitrogen (1 percent level), and zinc (5 percent level), whereas those produced on the treated site were significantly higher in phosphorus (1 percent level) (Table 133).

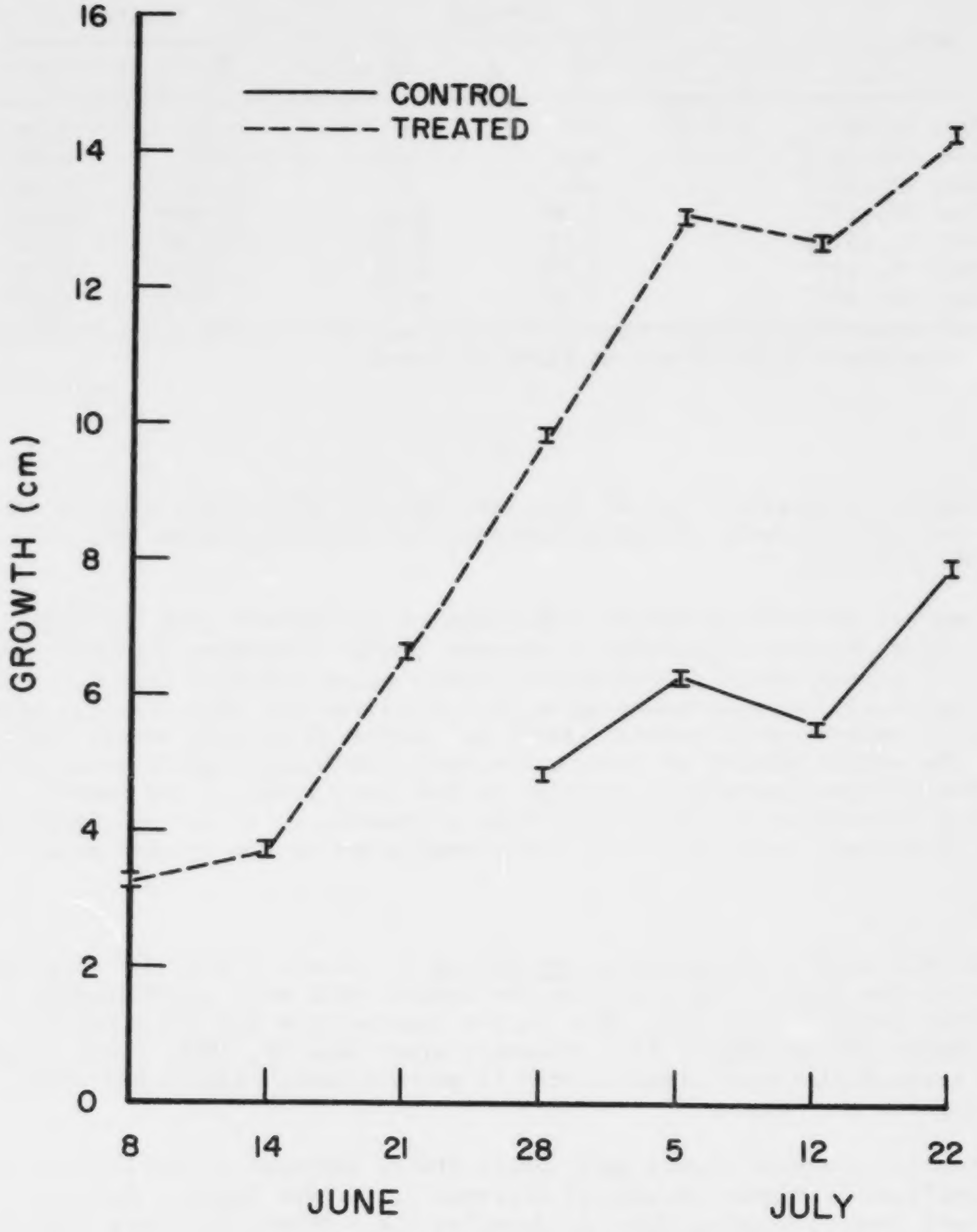


Figure 26. Influence of sewage effluent on the growth of lettuce, 1977.

TABLE 94. INFLUENCE OF SEWAGE EFFLUENT ON FRESH AND DRY WEIGHTS OF LETTUCE PLANTS (10 PLANTS PER REPLICATION PER TREATMENT), 1977

Block	Control			Treated		
	Fresh Weight (Grams/ Meter)	Dry Weight (Grams/ Meter)	% Moisture	Fresh Weight (Grams/ Meter)	Dry Weight (Grams/ Meter)	% Moisture
I	138	7	95	1783	267	85
II	750	51	93	2903	450	85
III	160	7	96	2074	311	85
IV	349	22	94	372	41	89
$\overline{X}$	349	22	95	1783	267	86
	*	*	**	*	*	**

*, ** = Significantly different at the 0.05 and 0.01 levels, respectively.

TABLE 95. COMBINED ANALYSIS OF LETTUCE FRESH WEIGHTS FOR 1976 AND 1977

Source	DF	SS	MS	F
Replications (R) Within Year	6	4,702,012.79	783,668.80	2.20
Year (Y)	1	21,506,151.12	21,506,151.12	60.31**
Treatment (T)	1	13,572,279.73	13,572,279.73	38.06**
Y x T	1	667,149.91	667,149.91	1.87
R x T	6	2,139,704.00	356,617.33	
Total	15	42,587,297.52	---	
Correction Factor	1	79,249,298.38	---	
Uncorrected Total	16	121,836,595.95		

** = Significantly different at the 0.01 level.

TABLE 96. COMBINED ANALYSIS OF LETTUCE DRY WEIGHTS FOR 1976 AND 1977

Source	DF	SS	MS	F
Replications (R) Within Year	6	51,155.90	8,525.98	<1.00
Year (Y)	1	520.29	520.29	<1.00
Treatment (T)	1	124,037.80	124,037.80	11.83*
Y x T	1	19,390.57	19,390.57	1.85
R x T	6	42,506.72	7,084.45	
Total	15	237,610.92	---	
Correction Factor	1	308,058.30	---	
Uncorrected Total	16	545,669.22		

* = Significantly different at the 0.05 level.

TABLE 97. INFLUENCE OF SEWAGE EFFLUENT ON MEAN WEEKLY GROWTH (HEIGHT - CM) OF ONIONS, 1976

Date	Control		Treated	
	$\bar{X}$	± SE	$\bar{X}$	± SE
May 22, 1976	0.79	0.11	0.92	0.04
May 28, 1976	7.06	0.29	8.46**	0.43
June 5, 1976	10.37	0.31	12.53**	0.46
June 15, 1976	15.38	0.46	17.89**	0.71
June 23, 1976	16.63	0.76	22.28**	1.25
June 29, 1976	18.90	0.63	27.93**	0.92
July 8, 1976	27.20	0.96	34.60**	1.47
July 15, 1976	37.35	0.90	46.63**	1.25
July 22, 1976	44.58	0.99	55.33**	1.24
July 29, 1976	44.58	1.82	58.38**	2.08
August 5, 1976	52.08	1.18	61.93**	1.34
August 12, 1976	60.20	1.88	70.15**	1.61

** = Significantly different at 0.01 level.

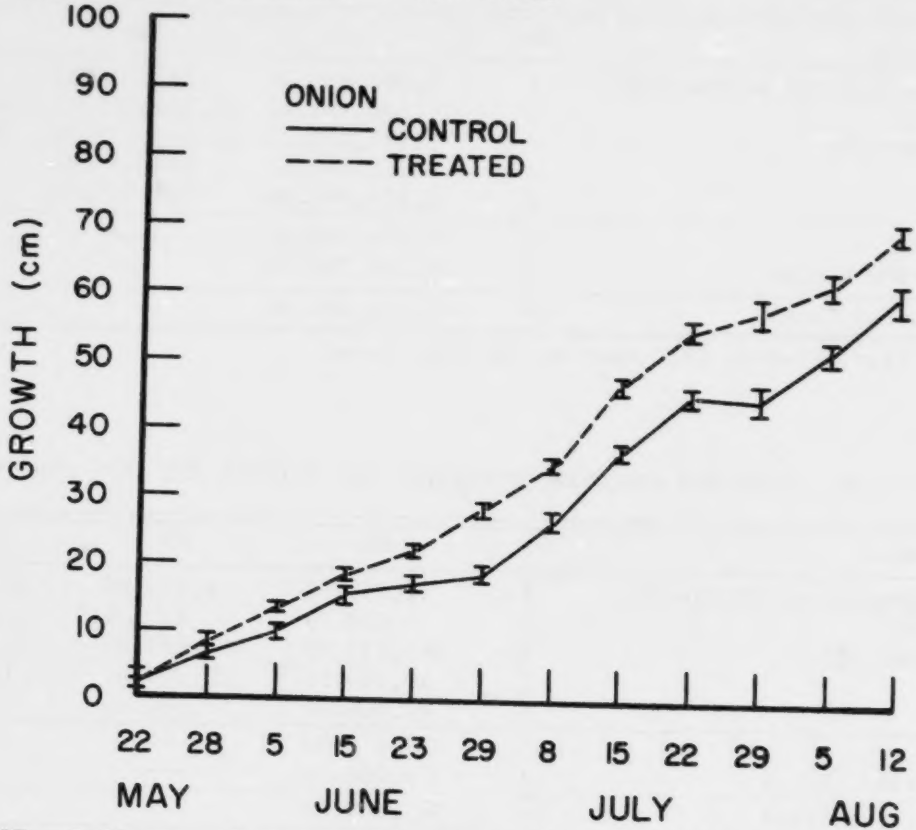


Figure 27. Influence of sewage effluent on the growth of onions, 1976.

TABLE 98. INFLUENCE OF SEWAGE EFFLUENT ON FRESH AND DRY WEIGHTS, NUMBER OF PLANTS PER METER, AND PERCENT MOISTURE IN ONIONS

Blocks	Control				Treated			
	(gms/meter) Fresh Weight	(gms/meter) Dry Weight	% Moisture	Plants/ Meter	(gms/meter) Fresh Weight	(gms/meter) Dry Weight	% Moisture	Plants/ Meter
I	1432	527	63	18	1643	335	80	10
II	740	391	47	18	1109	460	59	7
III	454	305	33	10	1024	751	27	6
IV	1219	256	79	9	661	295	55	5
$\overline{X}$	961	370	56	14	1109	460	55	10*

* = Significantly different at 0.05 level.

Wheat

In 1976 wheat, Triticum vulgare L., planted on the treated site emerged on about the same day as did those planted on the control site. Weekly growth data are shown in Table 123 and Figure 34. During the first two weeks, there was no significant difference in the rate of growth of wheat at the two sites. Beginning on May 22, 1976, and continuing through June 23, 1976, the growth rate of wheat on the treated site was significantly (1 percent level) greater than those on the control site.

Entire plants were harvested and fresh and dry weights of plants and seeds recorded (Table 124). There was no significant difference in fresh or dry weight of plants grown on the two sites. Plants and seeds from the control site had a significantly (1 percent level and 5 percent level, respectively) higher moisture content at harvest time than did those on the treated site. This is reflected by the fact that plants growing on the treated site were more mature at the time of harvest.

In wheat, the components of yield are the average number of plants per row length, the average number of seeds per head and the average seed size (weight). Although the same seeding rate existed for both sites, the treated site had a significantly (1 percent level) higher number of plants per meter, but significantly (1 percent level) fewer seeds per head (Table 125). Using the mean values of the components of yield, we can calculate 161 gms of seed per meter (1.1 lbs/foot) for the control site and 203 gms per meter (1.4 lbs/foot) for the treated site, for a difference of about 31 percent.

Weekly growth data for wheat in 1977 are shown in Table 126 and Figure 35. Generally, the variation in plant height was sporadic during the growing season. For the most part there was no significant difference in the growth of the plants on the two sites. This general uniformity is again emphasized when the plants and seeds were harvested (Table 127). Examination of the

TABLE 99. INFLUENCE OF SEWAGE EFFLUENT ON MEAN WEEKLY GROWTH (HEIGHT - CM) OF PEAS, 1976

Date	Control			Treated		
	$\bar{X}$	±	SE	$\bar{X}$	±	SE
May 8, 1976	1.26		0.03	1.34		0.04
May 15, 1976	2.75		0.11	2.99		0.13
May 22, 1976	7.96		0.19	8.31		0.19
May 28, 1976	9.11		0.28	11.14**		0.41
June 5, 1976	22.63		0.52	27.33**		0.85
June 15, 1976	38.93		0.74	42.15*		1.39
June 23, 1976	39.98		1.32	48.55**		1.52
June 29, 1976	41.28		1.49	50.65**		1.32
July 8, 1976	49.33		0.96	55.58**		1.56

*, ** = Significantly different at 0.05 and 0.01 level, respectively.

components of yield showed that only the number of plants per meter was significantly (5 percent level) higher on the treated site than on the control site (Table 128). Although we used a different cultivar of wheat in 1977 than that used in 1976, when all of the data were combined, there was no significant difference due to year, treatment or interactions of year times treatment (Tables 129, 130, 131, and 132).

Chemical analysis of the wheat plants showed only a significantly (1 percent level) higher amount of zinc in the plants grown on the control site (Table 133). Significantly (5 percent level) greater quantities of potassium and phosphorus accumulated in the heads produced on the treated site, whereas those produced on the control site had significantly higher amounts of sodium (1 percent level) and zinc (5 percent level). The chemical analysis of the wheat heads included the glumes, lemna, and palea (chaff) as well as the seeds. When 100 seeds were analyzed, only those produced on the control site were significantly (1 percent level) higher in sodium and zinc.

Alfalfa Hay from Treated and Control Site

The first cutting of hay harvested from the treated site (not garden plots) and the control site (not garden plots) produced a yield of 1970 and 2330 bales, respectively. The bales from the treated site contained more grass and thus weighed about 27 kg (60 lbs) each, whereas those on the control site contained more alfalfa and weighed about 30 kg (66 lbs) each. The estimated yield from the treated site was about 53,572 kg (59 tons), while that from the control site was about 69,916 kg (77 tons). No second crop of hay was taken from the treated site because the farmer pastured cattle on the site, the rest of the summer.

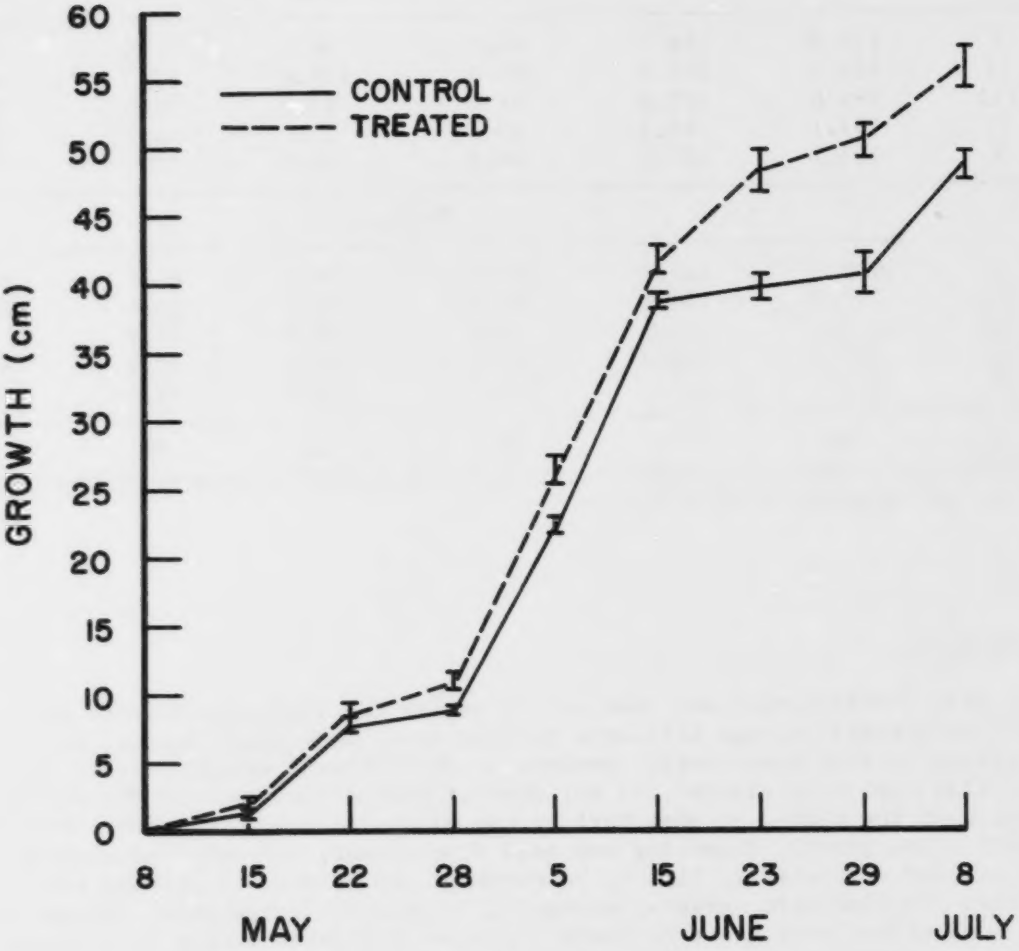


Figure 28. Influence of sewage effluent on the mean weekly growth (height - cm) of peas, 1976.

TABLE 100. INFLUENCE OF SEWAGE EFFLUENT ON FRESH AND DRY WEIGHTS OF PLANT, PODS, AND SEEDS OF PEAS (HARVESTED 1 M - ROW), 1976

Blocks	Fresh Weight (gms/meter)			Dry Weight (gms/meter)		
	Plant	Pod	Seed	Plant	Pod	Seed
	Control					
I	216.8	98.4	64.7	36.2	14.5	14.2
II	650.3	287.8	180.3	119.4	43.3	40.8
III	295.6	125.5	64.4	53.3	19.0	15.2
IV	251.1	98.7	83.4	55.1	16.7	21.8
$\bar{X}$	353.5	152.6	98.2	66.0	23.4	23.0
	Treated					
I	1468.9	446.9	417.5	156.3	60.9	98.2
II	359.7	176.6	155.3	68.4	23.8	35.6
III	318.6	92.6	34.6	49.2	12.5	6.2
IV	819.5	333.8	191.8	145.6	48.3	41.7
$\bar{X}$	742.7	267.5	199.8	104.9	36.4	45.4
	NS	NS	NS	NS	NS	NS

NS = Not significantly different.

Discussion

This investigation was designed to assess the long-term effects of applying domestic sewage effluents to crop land, more specifically, to determine whether heavy metals present in the effluent waters entered economically important plants. If so, whether they accumulated in the edible portion of the plant, in what part of the plant did they accumulate, did they affect plant growth, flowering and seed development, and were the amounts accumulated sufficiently high to be phytoxic and harmful to animals and humans. To elucidate answers, economically important vegetable, forage, root, and seed crops, were grown in field plots and irrigated weekly with sewage effluents from the municipal treatment facility at Tooele, Utah.

Chemical analyses of the plant material indicated that heavy metals were detected in the plants; however, with few exceptions, plants growing on the control garden plot were higher in the heavy metals copper, iron, and zinc (Table 133). Generally, the levels of heavy metals observed in the plants in this study were lower than amounts reportedly harmful (Kirkham, 1975; Jones et al., 1975; Cunningham et al., 1975a, 1975b, 1975c). The element most consistently higher in plants grown on the treated garden site than in those on the control garden site was sodium. Higher levels of sodium may have resulted from detergents in the domestic sewage effluents (Judy, Martens and

TABLE 101. INFLUENCE OF SEWAGE EFFLUENT ON YIELD COMPONENTS OF PEAS, NUMBER OF PLANTS PER METER, NUMBER OF PODS PER PLANT, NUMBER OF SEEDS PER POD, AVERAGE SEED WEIGHT, AND SEEDS PER METER, 1976

Blocks	Plants/ Meter	Pods/ Plant	Seeds/ Pod	Avg. Seed Wt. (gm)	Seeds/ Meter
			Control		
I	4.0	9.5	5.8	0.06	220.4
II	11.0	12.3	6.2	0.05	838.9
III	4.0	13.3	6.5	0.04	345.8
IV	6.0	9.8	6.2	0.06	364.6
$\bar{X}$	6.3	11.2	6.2	0.05	442.43
			Treated		
I	22.0	6.7	5.7	0.12	840.2
II	5.0	13.6	6.6	0.08	448.8
III	2.0	17.5	6.5	0.03	227.5
IV	5.0	25.4	6.3	0.05	800.1
$\bar{X}$	8.5	15.8	6.3	0.07	579.2
	NS	**	NS	NS	NS

** = Significant at $P < 0.01$ level.
NS = Not significantly different.

Kroontje, 1973). On occasion, higher amounts of nitrogen, phosphorus, and potassium were noted in plants grown on the treated garden site.

Compared with the controls, plants grown on the treated garden site generally exhibited greater growth. One of the criterion used in trying to explain these differences was the ratio root weight/shoot weight (R/S). Although the R/S ratio is similar in plants of a species under identical environmental conditions, it may be modified by reciprocal correlative influences between the aerial parts of a plant and its roots. The kind and magnitude of these correlative effects depend largely upon the environmental conditions to which the plant is exposed during a given growth period. With this in mind, R/S ratios were determined on carrots and radishes from the two sites for 1976 and 1977. As noted in Table 73 for carrots and in Tables 113 and 115 for radishes, there was no significant differences in the R/S ratio for either crop.

In forage crop studies, the leaf-stem (L/S) ratio is often used as a basis of comparison of treatments. The leaves of all forage plants are greatly superior to the stems in nutritive value (Sotola, 1933). Stems are superior in composition, because they have higher percentages of the more

TABLE 102. INFLUENCE OF SEWAGE EFFLUENT ON MEAN WEEKLY GROWTH (HEIGHT - CM) OF PEAS, 1977

Date	Control			Treated		
	X̄	±	SE	X̄	±	SE
June 1, 1977	4.23		0.21	4.97*		0.26
June 8, 1977	9.93		0.41	10.18 NS		0.46
June 14, 1977	16.98		0.84	18.93*		0.47
June 21, 1977	26.25		0.68	27.65 NS		0.84
June 28, 1977	33.75		1.09	32.40 NS		0.94
July 5, 1977	40.08		1.12	40.03 NS		1.25
July 12, 1977	35.60		1.34	35.20 NS		1.40
July 22, 1977	36.63		1.21	37.78 NS		1.35

* = Significantly different at the 0.05 level.
NS = Not significantly different.

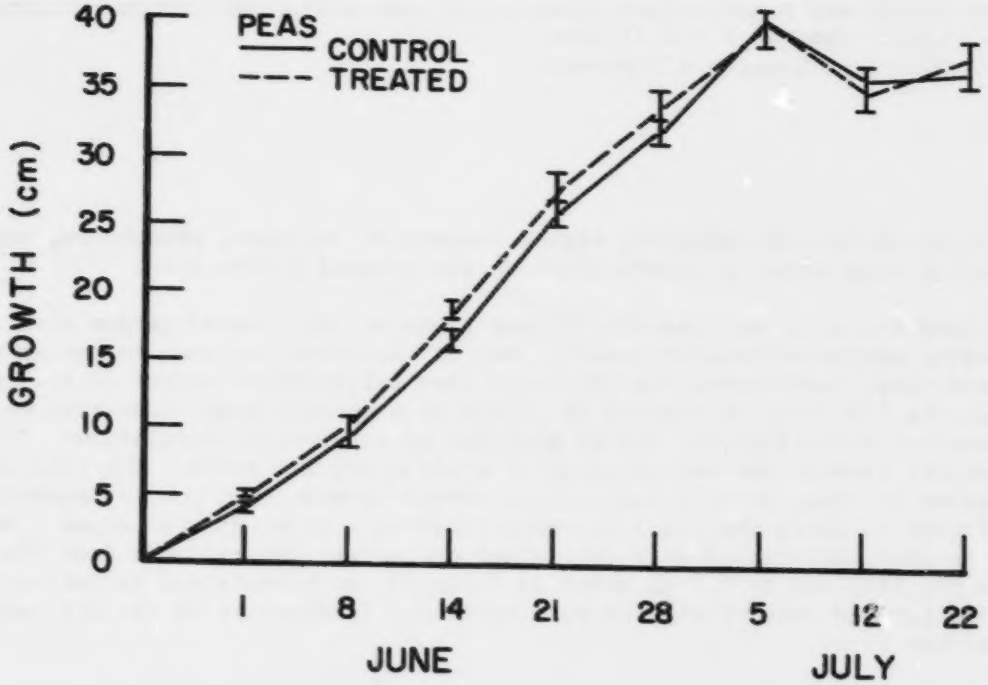


Figure 29. Influence of sewage effluent on the mean weekly growth (height - cm) of peas, 1977.

TABLE 103. INFLUENCE OF SEWAGE EFFLUENT ON FRESH AND DRY WEIGHTS OF PLANTS AND PERCENT MOISTURE OF PEAS, 1977

Blocks	Control			Treated		
	Fresh Weight (Grams/ Meter)	Dry Weight (Grams/ Meter)	% Moisture	Fresh Weight (Grams/ Meter)	Dry Weight (Grams/ Meter)	% Moisture
I	101	35	65	219	94	66
II	79	24	69	89	47	48
III	207	70	66	184	65	65
IV	209	56	73	228	66	71
$\overline{X}$	149	46	68	180	63	63
	NS	NS	NS	NS	NS	NS

NS = Not significantly different.

TABLE 104. INFLUENCE OF SEWAGE EFFLUENT ON YIELD COMPONENTS--NUMBER OF PLANTS PER METER, NUMBER OF PODS PER PLANT, NUMBER OF SEEDS PER POD, AND SEEDS PER METER, 1977

Blocks	Control				Treated			
	Plants/ Meter	Pods/ Plant	Seeds/ Pod	Seeds/ Meter	Plants/ Meter	Pods/ Plant	Seeds/ Pod	Seeds/ Meter
I	3	5	6	90	6	4	6	144
II	5	6	6	180	6	2	5	60
III	2	6	6	72	4	9	5	180
IV	6	2	4	48	6	4	6	144
$\overline{X}$	4	5	6	120	6	5	5	150
	NS	NS	NS	NS	NS	NS	NS	NS

NS = Not significantly different.

TABLE 105. COMBINED ANALYSIS OF PEA PLANT FRESH WEIGHTS FOR 1976 AND 1977

Source	DF	SS	MS	F
Replications (R) Within Year	6	314,684.48	52,447.41	<1.00
Year (Y)	1	587,407.28	587,407.28	5.09
Treatment (T)	1	175,917.33	175,917.33	1.53
Y x T	1	127,466.85	127,466.85	1.11
R x T	6	691,946.64	115,324.44	
Total	15	1,897,442.58	---	
Correction Factor	1	2,027,277.63	---	
Uncorrected Total	16	3,924,720.21		

TABLE 106. COMBINED ANALYSIS OF PEA PLANT DRY WEIGHTS FOR 1976 AND 1977

Source	DF	SS	MS	F
Replications (R) Within Year	6	4,296.16	716.03	<1.00
Year (Y)	1	3,828.51	3,828.51	2.27
Treatment (T)	1	3,049.80	3,049.80	1.81
Y x T	1	507.38	507.38	<1.00
R x T	6	10,104.86	1,684.14	
Total	15	21,786.71	---	
Correction Factor	1	78,330.02	---	
Uncorrected Total	16	100,116.73		

Table 107. COMBINED ANALYSIS OF NUMBER OF PEA PLANTS PER METER FOR 1976 AND 1977

Source	DF	SS	MS	F
Replications (R) Within Year	6	119.87	19.98	<1.00
Year (Y)	1	27.57	27.57	<1.00
Treatment (T)	1	14.07	14.07	<1.00
Y x T	1	0.55	0.55	<1.00
R x T	6	174.88	29.15	
Total	15	336.94	---	
Correction Factor	1	588.06	---	
Uncorrected Total	16	925.00		

TABLE 108. COMBINED ANALYSIS OF NUMBER OF PEA PODS PER PLANT FOR 1976 AND 1977

Source	DF	SS	MS	F
Replications (R) Within Year	6	121.16	20.19	1.14
Year (Y)	1	302.76	302.76	17.11**
Treatment (T)	1	21.63	21.63	1.22
Y x T	1	20.24	20.24	1.14
R x T	6	106.13	17.69	
Total	15	571.92	---	
Correction Factor	1	1,343.22	---	
Uncorrected Total	16	1,915.14		

** = Significantly different at the 0.01 level.

TABLE 109. COMBINED ANALYSIS OF NUMBER OF PEA SEEDS PER POD FOR 1976 AND 1977

Source	DF	SS	MS	F
Replications (R) Within Year	6	2.58	0.43	1.16
Year (Y)	1	2.18	2.18	5.88
Treatment (T)	1	0.05	0.05	<1.00
Y x T	1	0.18	0.18	<1.00
R x T	6	2.23	0.37	
Total	15	7.22	--	
Correction Factor	1	548.73	--	
Uncorrected Total	16	555.95		

TABLE 110. INFLUENCE OF SEWAGE EFFLUENT ON MEAN WEEKLY GROWTH (HEIGHT - CM) OF POTATOES, 1976

Date	Control		Treated	
	$\overline{X}$	± SE	$\overline{X}$	± SE
May 22, 1976	3.65	0.17	4.22*	0.12
May 28, 1976	4.96	0.29	5.64	0.30
June 5, 1976	15.43	0.52	18.75**	0.79
June 15, 1976	25.45	0.69	34.20**	0.77
June 23, 1976	33.88	0.88	34.30	1.08
June 29, 1976	26.68	0.90	27.75	0.65
July 8, 1976	31.30	1.19	30.08	0.83
July 15, 1976	36.55	1.74	32.90	1.14

*, ** = Significantly different at 0.05 and 0.01 level, respectively.

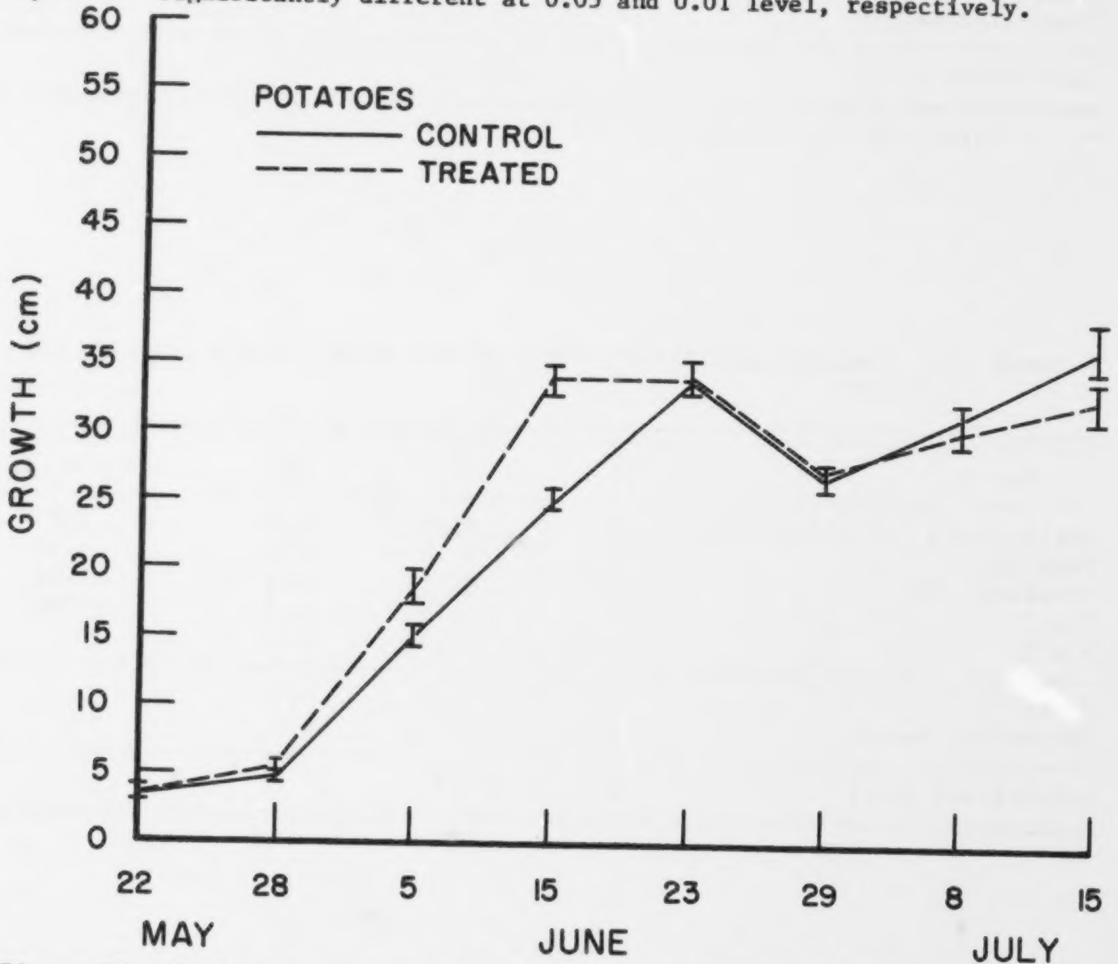


Figure 30. Influence of sewage effluent on the growth of potatoes.

TABLE 111. INFLUENCE OF SEWAGE EFFLUENT ON THE NUMBER OF U.S. No. 1, 2, AND 3 GRADE OF POTATOES (TOTAL FOR FIVE PLANTS)

Blocks	Control			Treated		
	No. 1	No. 2	No. 3	No. 1	No. 2	No. 3
I	17	4	9	29	12	9
II	29	4	10	19	12	16
III	17	10	19	5	12	11
IV	5	23	15	15	10	9
$\overline{X}$	17	8	13	17	12	11
	NS	NS	NS	NS	NS	NS

NS = Not significantly different.

valuable constituents and a lower percentage of the less valuable fiber. A given weight of leaves is almost three and one-half times as efficient as the same weight of stems in supplying digestible protein, and the leaves are much less bulky. In this study, higher L/S ratios were observed in the plants from the control garden site for both years.

Components of yield are, in order of their development, the average number of plants per row length, the number of seed per plant, and seed size (weight). As such, the components of yield offer a good basis of comparison between treatments. Interestingly, reductions in numbers of seeds per plant were accompanied by an increase in seed weight as in the case of beans, peas, and wheat. This may represent yield component compensation (Adams, 1967). Also in wheat, the same seeding rate was used, yet the treated garden site had a significantly higher number of plants per meter, but significantly fewer seeds per head. The increased number of plants per meter probably is a response to the increased nutritional value of the effluent, which apparently stimulated tillering.

IMPLICATIONS FOR LONG TERM EFFECTS

Although the treated municipal effluent applied to the treated garden site was of a significantly poorer quality than the normal irrigation water applied to the control garden site, there appears to be no significant long term harmful effects of using the treated effluent. In general, the plants grown with the treated municipal effluent exhibited greater growth than plants grown with the normal irrigation water. This increase in growth is probably due to the higher nutrient concentrations (i.e., nitrogen, phosphorus, etc.) in the wastewater compared to the normal irrigation water.

TABLE 112. INFLUENCE OF SEWAGE EFFLUENT ON THE MEAN WEEKLY GROWTH (CM) OF RADISH, 1976

Date	Control			Treated		
	$\overline{X}$	±	SE	$\overline{X}$	±	SE
May 8, 1976	0.12		0.02	0.11 NS		0.03
May 15, 1976	0.65		0.03	0.73 NS		0.04
May 22, 1976	1.87		0.08	1.76 NS		0.08
May 28, 1976	10.15		0.33	11.65**		0.17
June 5, 1976	15.25		0.37	17.20**		0.64
June 15, 1976	21.80		0.57	24.28*		0.91
June 23, 1976	35.23		1.34	35.48 NS		2.12

*, ** = Significantly different at the 0.05 and 0.01 levels, respectively.
NS = Not significant different.

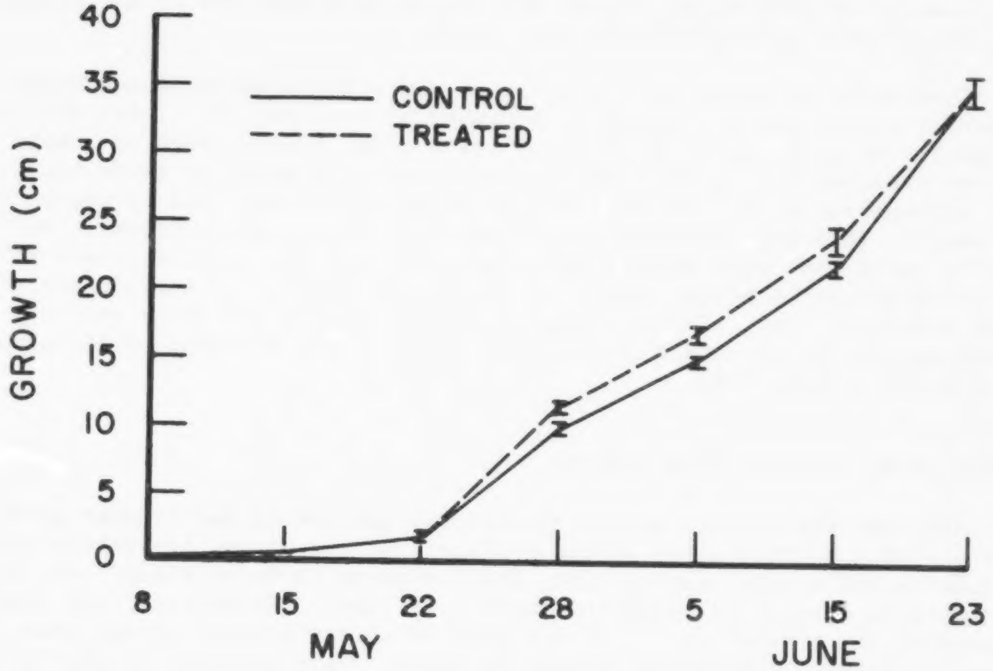


Figure 31. Influence of sewage effluent on mean weekly growth (cm) of radish plants, 1976.

TABLE 113. INFLUENCE OF SEWAGE EFFLUENT ON THE FRESH AND DRY WEIGHTS (GMS) AND THE ROOT/SHOOT (R/S) RATIO OF RADISH, 1976

Blocks	Fresh Weight (Grams/Meter)			Dry Weight (Grams/Meter)		
	Shoots	Roots	R/S Ratio	Shoots	Roots	R/S Ratio
	Control					
I	1108	449	0.41	63	34	0.54
II	781	493	0.63	52	38	0.73
III	722	235	0.33	54	22	0.41
IV	564	155	0.27	47	14	0.30
$\bar{X}$	794	333	0.42	54	27	0.50
	Treated					
I	1391	596	0.43	84	45	0.54
II	517	108	0.21	44	11	0.25
III	943	403	0.43	67	39	0.58
IV	746	362	0.49	73	34	0.47
$\bar{X}$	899	367	0.41	67	32	0.48
	NS	NS	NS	NS	NS	NS

NS = Not significantly different.

In general, the plants grown on the control garden plots had significantly higher values of heavy metals (copper, iron, zinc) than plants grown with the treated wastewater even though, in general, the wastewater contained higher concentrations of heavy metals. However, none of the heavy metals contents of the plants in this study were above reported harmful limits. In addition, the concentrations of heavy metals in the wastewater and the normal irrigation water were below recommended limits established for irrigation water quality.

Plants grown with the treated municipal effluent were higher in sodium than plants grown with the normal irrigation water. This is probably due to the greater sodium concentration of the treated municipal effluent (i.e., 129 mg/l vs. 19 mg/l).

Based on the results of this study there appears to be little significant difference between crops grown on land which has received treated municipal effluent for 20 years compared to plants grown on land which has received normal irrigation water for a similar period of time.

TABLE 114. INFLUENCE OF SEWAGE EFFLUENT ON THE MEAN WEEKLY GROWTH (CM) OF RADISH, 1977

Date	Control		Treated	
	$\overline{X}$	± SE	$\overline{X}$	± SE
June 1, 1977	1.50	0.00	1.94**	0.07
June 8, 1977	5.03	0.25	6.38**	0.28
June 14, 1977	7.03	0.28	9.50**	0.23
June 21, 1977	16.70	0.84	21.80**	0.71
June 28, 1977	46.65	1.48	49.70 NS	1.66
July 5, 1977	58.80	1.56	60.73 NS	1.40

** = Significantly different at the 0.01 level.

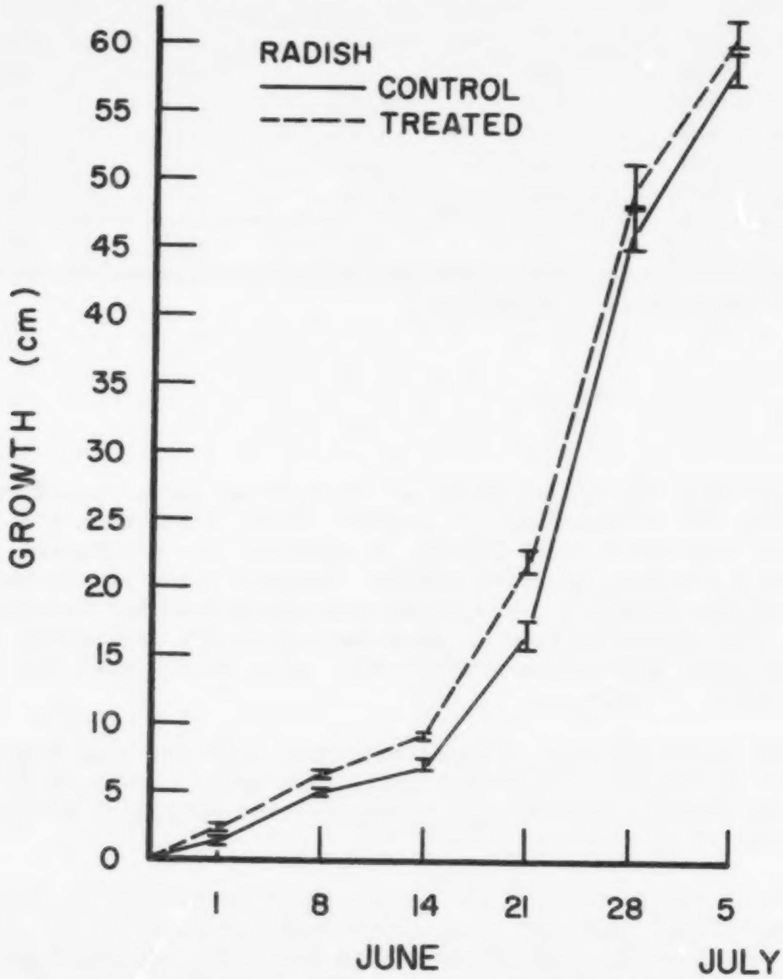


Figure 32. Influence of sewage effluent on mean weekly growth (cm) of radish plants, 1977.

TABLE 115. INFLUENCE OF SEWAGE EFFLUENT ON THE FRESH AND DRY WEIGHTS AND THE ROOT/SHOOT (R/S) RATIO OF RADISH, 1977

	Control					
Blocks	Fresh Weight (Grams/Meter)			Dry Weight (Grams/Meter)		
	Shoots	Roots	R/S Ratio	Shoots	Roots	R/S Ratio
I	198	41	0.21	51	9	0.18
II	632	56	0.09	187	15	0.08
III	532	43	0.08	136	8	0.06
IV	486	62	0.13	133	13	0.09
$\bar{X}$	462	51	0.11	127	11	0.10
	Treated					
I	440	29	0.07	96	8	0.08
II	716	70	0.10	315	15	0.05
III	284	26	0.09	29	9	0.32
IV	499	40	0.08	72	10	0.13
$\bar{X}$	485	42	0.09	128	10	0.15
	NS	NS	NS	NS	NS	NS

NS = Not significantly different.

TABLE 116. COMBINED ANALYSIS OF RADISH TOPS FRESH WEIGHTS FOR 1976 AND 1977

Source	DF	SS	MS	F
Replications (R) Within Year	6	614,181.04	102,363.51	3.95
Year (Y)	1	557,252.39	557,252.39	21.52**
Treatment (T)	1	16,505.82	16,505.82	<1.00
Y x T	1	7,773.55	7,773.55	<1.00
R x T	6	155,339.02	25,889.84	
Total	15	1,351,051.83	---	
Correction Factor	1	6,966,590.73	---	
Uncorrected Total	16	8,317,642.55		

** = Significantly different at the 0.01 level.

TABLE 117. COMBINED ANALYSIS OF RADISH TOPS DRY WEIGHTS FOR 1976 AND 1977

Source	DF	SS	MS	F
Replications (R) Within Year	6	42,243.93	7,040.66	2.47
Year (Y)	1	17,937.92	17,937.92	6.29*
Treatment (T)	1	190.92	190.92	<1.00
Y x T	1	137.30	137.30	<1.00
R x T	6	17,117.42	2,852.90	
Total	15	77,627.47	---	
Correction Factor	1	141,050.95	---	
Uncorrected Total	16	218,678.42		

* = Significantly different at the 0.05 level.

Table 118. COMBINED ANALYSIS OF RADISH ROOTS FRESH WEIGHTS FOR 1976 AND 1977

Source	DF	SS	MS	F
Replications (R) Within Year	6	63,052.10	10,508.68	<1.00
Year (Y)	1	378,747.93	378,747.93	19.39**
Treatment (T)	1	1,067.66	1,067.66	<1.00
Y x T	1	2,598.45	2,598.45	<1.00
R x T	6	117,217.61	19,536.27	
Total	15	562,683.75	---	
Correction Factor	1	639,400.14	---	
Uncorrected Total	16	1,202,083.89		

** = Significantly different at the 0.01 level.

TABLE 119. COMBINED ANALYSIS OF RADISH ROOTS DRY WEIGHTS FOR 1976 AND 1977

Source	DF	SS	MS	F
Replications (R) Within Year	6	372.41	62.07	<1.00
Year (Y)	1	1,420.34	1,420.34	12.33
Treatment (T)	1	19.03	19.03	<1.00
Y x T	1	38.60	38.60	<1.00
R x T	6	690.91	115.15	
Total	15	2,541.69	---	
Correction Factor	1	6,502.41	---	
Uncorrected Total	16	9,044.10		

* = Significantly different at the 0.05 level.

TABLE 120. COMBINED ANALYSIS OF FRESH WEIGHTS OF RADISH ROOT/SHOOT (R/S) RATIOS FOR 1976 AND 1977

Source	DF	SS	MS	F
Replications (R) Within Year	6	0.00	0.00	
Year (Y)	1	0.34	0.34	17.00**
Treatment (T)	1	0.00	0.00	
Y x T	1	0.00	0.00	
R x T	6	0.12	0.02	
Total	15	0.47	--	
Correction Factor	1	1.03	--	
Uncorrected Total	16	1.50		

** = Significantly different at the 0.01 level.

TABLE 121. COMBINED ANALYSIS OF DRY WEIGHTS OF RADISH ROOT/SHOOT (R/S) RATIOS FOR 1976 AND 1977

Source	DF	SS	MS	F
Replications (R) Within Year	6	0.05	0.01	<1.00
Year (Y)	1	0.49	0.49	16.33**
Treatment (T)	1	0.00	0.00	0.00
Y x T	1	0.02	0.02	<1.00
R x T	6	0.15	0.03	
Total	15	0.71	--	
Correction Factor	1	1.45	--	
Uncorrected Total	16	2.16		

** = Significantly different at the 0.01 level.

TABLE 122. INFLUENCE OF SEWAGE EFFLUENT ON THE MEAN WEEKLY GROWTH (CM) OF TOMATO, 1976

Date	Control		Treated	
	$\bar{X}$	± SE	$\bar{X}$	± SE
May 28, 1976	18.85	0.67	16.60*	0.63
June 5, 1976	23.03	0.78	19.33**	0.84
June 15, 1976	21.75	0.75	20.48	1.18
June 23, 1976	26.93	0.93	26.43	0.76
June 29, 1976	24.03	1.21	26.98*	0.79
July 8, 1976	28.93	1.37	36.68**	1.17
July 15, 1976	31.58	1.74	48.10**	1.05
July 22, 1976	40.73	1.77	53.30**	1.47
July 29, 1976	53.53	1.75	75.00**	1.90
August 5, 1976	59.18	1.85	77.83**	1.94
August 12, 1976	71.13	1.98	81.70**	1.95
August 19, 1976	72.05	2.17	90.63**	2.24
August 25, 1976	83.85	2.13	91.58**	2.00

*, ** = Significantly different at 0.05 and 0.01 levels, respectively.

TABLE 123. INFLUENCE OF SEWAGE EFFLUENT ON THE MEAN WEEKLY GROWTH (HEIGHT - CM) OF WHEAT, 1976

Date	Control		Treated	
	$\bar{X}$	± SE	$\bar{X}$	± SE
May 8, 1976	3.9	0.05	3.9	0.06
May 15, 1976	12.3	0.36	12.3	0.33
May 22, 1976	18.3	0.45	20.6**	0.35
May 28, 1976	23.0	0.63	28.9**	0.52
June 5, 1976	33.2	1.06	44.5**	0.77
June 15, 1976	44.6	0.89	53.8**	0.91
June 23, 1976	53.5	1.20	66.4**	1.92
June 29, 1976	54.9	0.98	56.4	1.61
July 8, 1976	60.0	1.08	60.1	1.01
July 15, 1976	63.7	1.35	63.7	0.94

** = Significantly different at the 0.01 level.

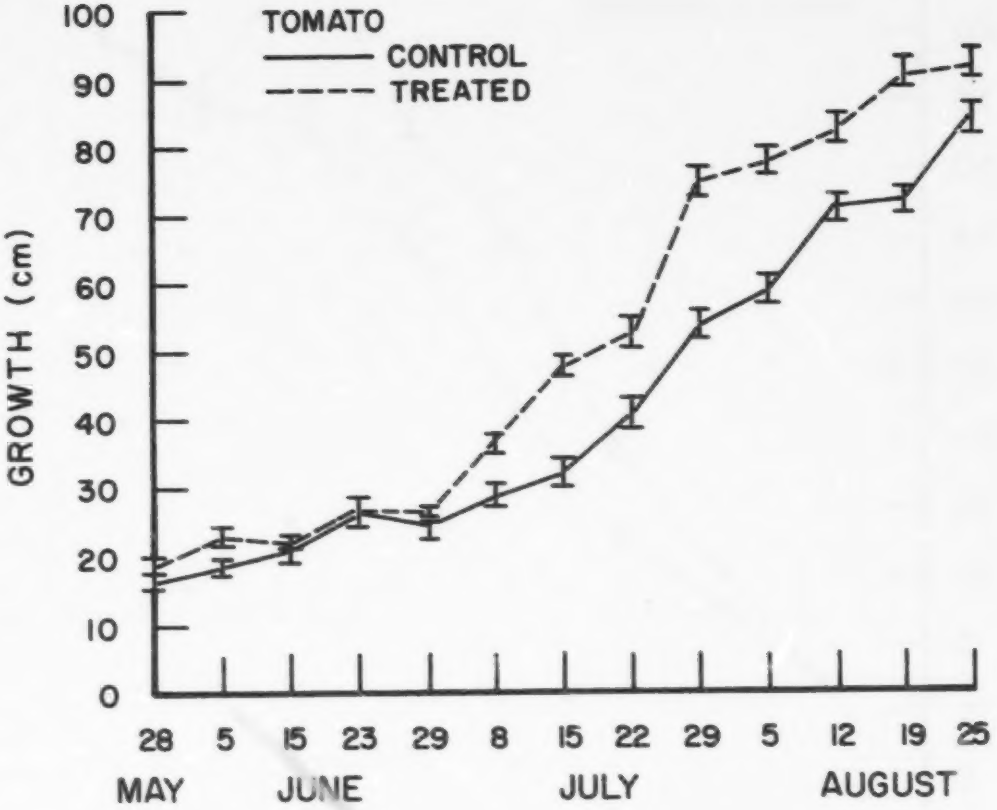


Figure 33. Influence of sewage effluent on the mean weekly growth (height - cm) of tomato, 1976.

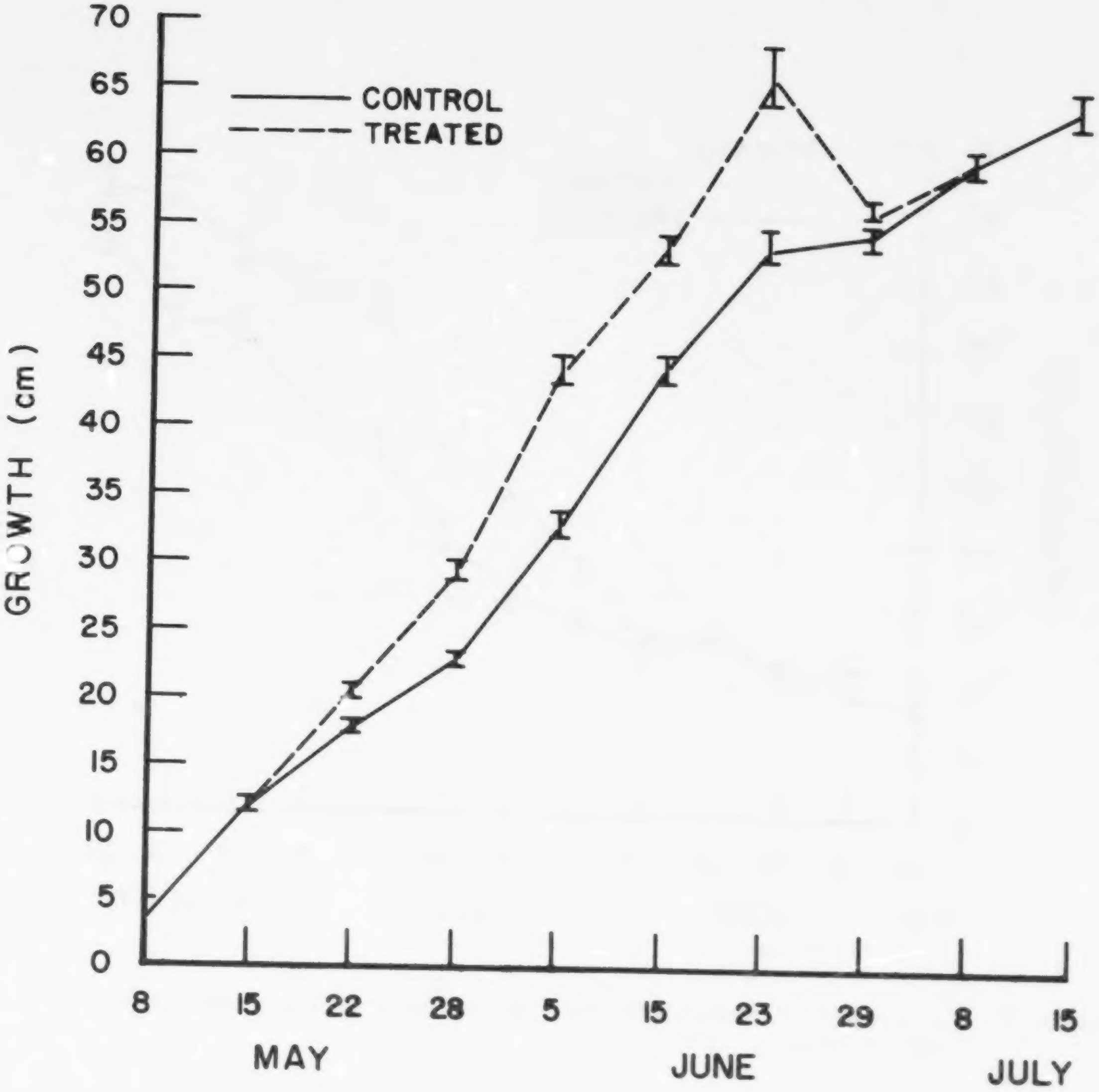


Figure 34. Influence of sewage effluent on the growth (cm) of wheat, 1976.

TABLE 124. INFLUENCE OF SEWAGE EFFLUENT ON FRESH AND DRY WEIGHTS (GMS) OF WHEAT PLANTS AND SEED AND PERCENT MOISTURE (HARVESTED 1 METER OF ROW), 1976

Blocks	Fresh Weight (Grams/Meter)		Dry Weight (Grams/Meter)		% Moisture	
	Plant	Seed	Plant	Seed	Plant	Seed
	Control					
I	201	276	66	150	67	46
II	173	201	51	94	71	53
III	453	405	174	117	62	71
IV	733	470	152	212	79	55
$\bar{X}$	390	338	110	144	70	56
	Treated					
I	304	368	170	164	44	55
II	404	106	140	93	65	13
III	184	227	86	188	53	17
IV	225	256	95	200	58	22
$\bar{X}$	279	239	73	161	55	27
	NS	NS	NS	NS	**	*

*, ** = Significantly different at the 0.05 and 0.01 levels, respectively.
NS = Not significantly different.

TABLE 125. INFLUENCE OF SEWAGE EFFLUENT ON YIELD COMPONENTS--AVERAGE NUMBER OF PLANTS PER METER, NUMBER OF SEEDS PER HEAD, AND AVERAGE SEED WEIGHT OF WHEAT, 1976

Blocks	Control				Treated			
	Plants/ Meter	Seeds/ Head	Ave. Seed Wt. (gms)	Seeds/ Meter	Plants/ Meter	Seeds/ Head	Ave. Seed Wt. (gms)	Seeds/ Meter
I	107	59	0.029	6,313	154	32	0.031	4,928
II	75	51	0.030	3,825	138	25	0.032	3,450
III	140	39	0.027	5,460	231	31	0.035	7,161
IV	156	41	0.027	6,396	200	51	0.031	10,200
$\bar{X}$	120	48	0.028	5,499	181	35	0.032	6,435
	**	**	NS	NS	**	**	NS	NS

** = Significant at $P < 0.01$ level.
NS = Not significantly different.

TABLE 126. INFLUENCE OF SEWAGE EFFLUENT ON THE MEAN WEEKLY GROWTH (HEIGHT - CM) OF WHEAT, 1977

Date	Control			Treated		
	$\overline{X}$	±	SE	$\overline{X}$	±	SE
June 1, 1977	11.40		0.09	10.05**		0.38
June 8, 1977	16.45		0.35	18.13**		0.13
June 14, 1977	21.25		0.43	21.20 NS		0.41
June 21, 1977	34.38		0.56	32.15**		0.51
June 28, 1977	45.98		0.86	45.10 NS		0.83
July 5, 1977	56.43		0.78	54.90 NS		1.01
July 12, 1977	51.78		0.83	53.78 NS		1.71
July 22, 1977	47.55		0.91	60.93**		1.55
July 29, 1977	57.53		0.73	60.58 NS		1.76
August 4, 1977	59.63		0.81	62.43 NS		1.89
August 12, 1977	57.95		0.84	60.08 NS		1.70

** = Significantly different at the 0.01 level.

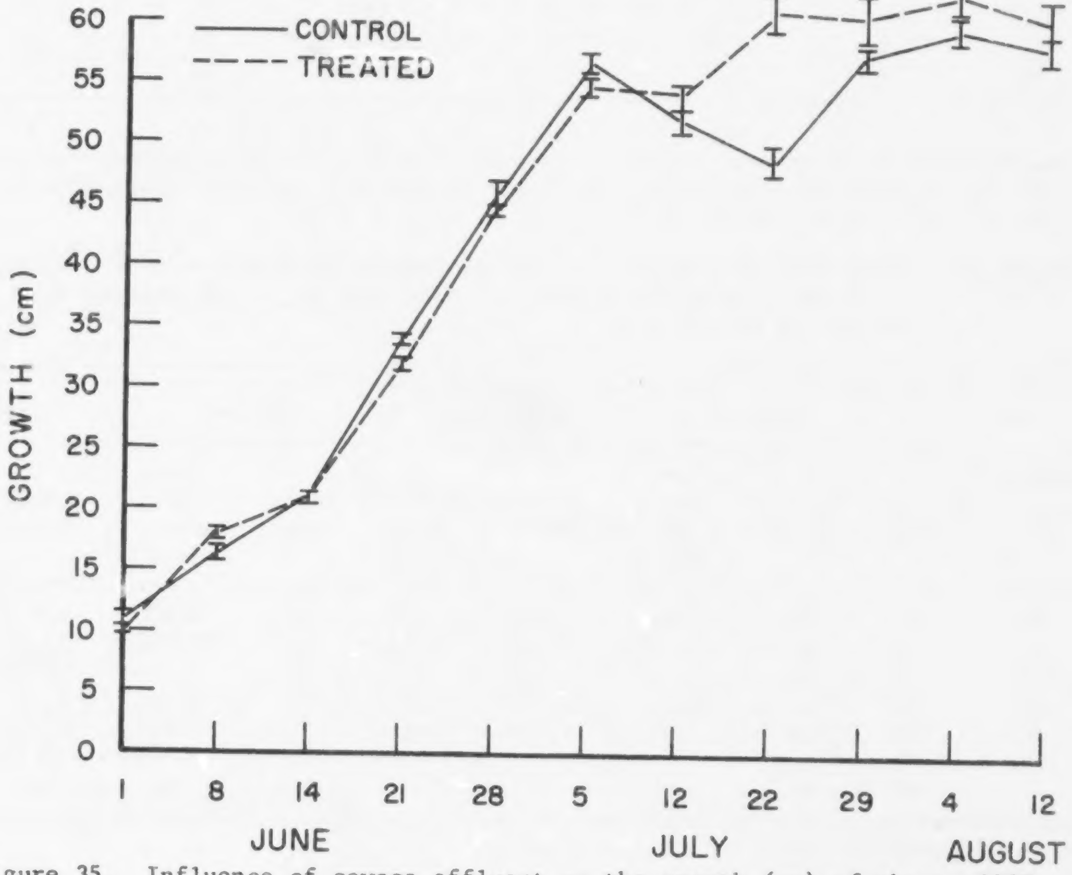


Figure 35. Influence of sewage effluent on the growth (cm) of wheat, 1977.

TABLE 127. INFLUENCE OF SEWAGE EFFLUENT ON FRESH AND DRY WEIGHTS (GMS) OF WHEAT PLANTS AND SEED AND PERCENT MOISTURE (HARVESTED 1 METER OF ROW), 1977

Blocks	Fresh Weight (Grams/Meter)		Dry Weight (Grams/Meter)		% Moisture	
	Plant	Seed	Plant	Seed	Plant	Seed
	Control					
I	464	180	156	148	66	18
II	169	77	50	63	70	17
III	243	88	83	75	66	15
IV	142	37	61	28	57	24
$\bar{X}$	255	95	87	78	65	19
	Treated					
I	921	320	289	248	69	22
II	331	127	135	105	59	18
III	788	188	229	140	71	26
IV	107	23	48	19	55	19
$\bar{X}$	536	165	175	128	64	21
	NS	NS	NS	NS	NS	NS

NS = Not significantly different.

TABLE 128. INFLUENCE OF SEWAGE EFFLUENT ON YIELD COMPONENTS--NUMBER OF PLANTS PER METER, NUMBER OF SEEDS PER HEAD, AVERAGE SEED WEIGHT, AND SEEDS PER METER, 1977

Blocks	Control				Treated			
	Plants/ Meter	Seeds/ Head	Seed Wt. (gms)	Seeds/ Meter	Plants/ Meter	Seeds/ Head	Seed Wt. (gms)	Seeds/ Meter
I	157	25	0.024	3,925	225	33	0.003	7,425
II	105	20	0.022	2,100	137	25	0.026	3,425
III	129	18	0.024	2,322	192	25	0.033	4,800
IV	33	27	0.027	891	46	14	0.015	644
$\bar{X}$	106	22	0.024	2,332	150	24	0.026	3,600
	*	NS	NS	NS	*	NS	NS	NS

* = Significantly different at 0.05 level.

NS = Not significantly different.

TABLE 129. COMBINED ANALYSIS OF WHEAT PLANTS FRESH WEIGHTS FOR 1976 AND 1977

Source	DF	SS	MS	F
Replications (R) Within Year	6	454,306.14	75,717.69	1.62
Year (Y)	1	14,792.64	14,792.64	<1.00
Treatment (T)	1	29,249.55	29,249.55	<1.00
Y x T	1	154,075.87	154,075.87	3.30
R x T	6	280,292.87	46,715.48	
Total	15	932,717.07	---	
Correction Factor	1	2,131,965.02	---	
Uncorrected Total	16	3,064,682.09		

TABLE 130. COMBINED ANALYSIS OF WHEAT PLANTS DRY WEIGHTS FOR 1976 AND 1977

Source	DF	SS	MS	F
Replications (R) Within Year	6	119,911.82	19,985.30	1.30
Year (Y)	1	6,304.37	6,304.37	<1.00
Treatment (T)	1	2,495.00	2,495.00	<1.00
Y x T	1	15,762.81	15,762.81	1.02
R x T	6	92,455.22	15,409.37	
Total	15	236,930.20	---	
Correction Factor	1	198,470.25	---	
Uncorrected Total	16	435,400.45		

TABLE 131. COMBINED ANALYSIS OF FRESH WEIGHTS OF 100 WHEAT SEEDS FOR 1976 AND 1977

Source	DF	SS	MS	F
Replications (R) Within Year	6	8.66	1.44	<1.00
Year (Y)	1	9.15	9.15	4.25
Treatment (T)	1	0.54	0.54	<1.00
Y x T	1	0.01	0.01	<1.00
R x T	6	12.88	2.15	
Total	15	31.23	--	
Correction Factor	1	248.85	--	
Uncorrected Total	16	280.08		

TABLE 132. COMBINED ANALYSIS OF DRY WEIGHTS OF 100 WHEAT SEEDS FOR 1976 AND 1977

Source	DF	SS	MS	F
Replications (R) Within Year	6	0.75	0.13	<1.00
Year (Y)	1	1.02	1.02	4.26
Treatment (T)	1	0.33	0.33	1.36
Y x T	1	0.04	0.04	<1.00
R x T	6	1.46	0.24	
Total	15	3.60	--	
Correction Factor	1	122.32	--	
Uncorrected Total	16	125.92		

TABLE 133. AVERAGE MEAN VALUE IN PERCENT AND PPM (PARTS PER MILLION) FOR CALCIUM (Ca), POTASSIUM (K), NITROGEN (N), PHOSPHORUS (P), CADMIUM (Cd), COPPER (Cu), IRON (Fe), SODIUM (Na), LEAD (Pb), AND ZINC (Zn), RESPECTIVELY FOR THE VARIOUS PLANTS TESTED

Plant Species	Plant Part	Treat	Percent				PPM					
			Ca	K	N	P	Cd	Cu	Fe	Na	Pb	Zn
Alfalfa	Stems 1st Har.	C[a]	1.08	2.58	2.05	0.16	10	9.25	82.5	290	40	30.00
		T	1.03	2.73	1.82	0.24	10	9.50	35.0**	600*	40	14.75**
	Stems 2nd Har.	C	1.28	2.28	1.63	0.11	10	8.00	277.50	525	40	39.25
		T	1.10	1.98	1.66	0.19	10	9.50*	72.50*	1195*	40	11.00**
	Leaves 1st Har.	C	2.25	2.15	4.54	0.23	10	11.50	137.50	287.50	40	38.00
		T	2.55	2.30	4.55	0.31	10	9.25**	112.50*	512.50**	40	21.00**
	Leaves 2nd Har.	C	2.98	1.93	3.86	0.21	10	10.75	505.00	660.00	40	35.25
		T	3.04	2.55**	4.33	0.28	10	8.00**	240.00	1175.00	40	34.25
Beans	Tops	C	3.61	2.35	3.18	0.21	10	11.00	317.50	292.50	40	36.50
		T	3.34	2.80	2.95	0.52	10	11.75	502.50	475.00*	40	19.75**
	Pods	C	0.55	2.55	2.57	0.23	10	10.00	85.00	130.00	40	27.00
		T	0.65*	4.23**	2.70	0.47**	10	10.00	87.50	215.00	40	15.25**
	Seeds	C	0.20	2.20	4.84	0.64	10	14.00	110.00	53.50	40	69.25
		T	0.22	2.70	4.81	0.65	10	13.25	167.50	80.25*	40	43.00**
Carrots	Tops	C	3.31	2.62	2.35	0.15	10	8.00	387.50	2400.00	40	76.00
		T	3.45	2.18	2.55	0.27*	10	11.00	567.50	6712.00**	40	39.75**
	Roots	C	0.24	2.78	1.24	0.23	10	11.50	95.00	1847.50	40	33.25
		T	0.29	3.28**	1.32	0.41	10	8.75**	150.00	4475.00*	40	19.50**
Corn	Plant	C	0.27	2.28	1.13	0.09	10	8.75	85.00	180.00	40	66.50
		T	0.26	2.13**	0.99	0.38	10	8.50	167.50	121.75*	40	30.75**

[a] C = control, T = treated or effluent site.

*, ** = Significantly different at 0.05 or 0.01 levels, respectively.

(continued)

TABLE 133. (CONTINUED)

Plant Species	Plant Part	Treat	Percent				PPM					
			Ca	K	N	P	Cd	Cu	Fe	Na	Pb	Zn
Corn (cont.)	Seeds	C	0.07	1.73	3.52	0.40	10	9.50	35.00	28.00	40	56.50
		T	0.05	1.40	2.52**	0.48	10	8.75*	27.50	21.50	40	42.25**
	Cobs	C	0.08	1.30	1.89	0.22	10	15.00	30.00	15.00	40	58.00
		T	0.05	1.00	0.77	0.21	10	8.00	20.00	16.00	40	32.00*
Lettuce	----	C	1.63	6.63	3.16	0.31	10	18.50	757.50	2400.00	40	71.75
		T	1.84	6.50	3.10	0.45**	10	12.50	615.00	7475.00**	40	35.25*
Onions	Tops	C	1.94	2.98	2.69	0.19	10	8.00	205.00	1100.00	40	25.75
		T	1.94	2.88	2.05**	0.28	10	8.00	211.75	2700.00	40	21.00
	Bulbs	C	0.91	1.20	1.63	0.23	10	8.00	57.50	477.50	40	53.50
		T	0.81	1.08	0.90**	0.24	10	8.00	130.00*	1280.00**	40	27.25**
Peas	Plants	C	2.32	1.88	2.70	0.18	10	8.00	125.00	575.00	40	94.25
		T	2.12	2.28**	2.50	0.29	10	8.00	197.50	865.00	40	39.50**
	Pods	C	0.66	1.18	2.60	0.22	10	8.00	62.50	167.50	40	37.50
		T	0.86	1.50	2.32	0.34	10	17.75	47.50	202.50	40	26.50
	Seeds	C	0.13	1.40	4.38	0.47	10	20.00	62.50	79.00	40	73.75
		T	0.16	1.43	3.58	0.54	10	25.50	140.00	42.25	40	59.00
Potatoes	Plants	C	3.10	2.73	1.85	0.12	10	37.75	1775.00	940.00	40	160.00
		T	3.52	2.55	1.27	0.17	10	13.50*	3225.00	1975.00**	40	32.00**
	Tubers	C	0.07	2.00	2.15	0.26	10	12.00	67.50	73.25	40	38.75
		T	0.07	1.84	2.63	0.33	10	11.75	72.50	307.50**	40	24.25**
Radish	Tops	C	3.39	3.10	3.89	0.23	10	13.25	242.50	3300.00	40	77.75
		T	2.52*	2.35*	2.72**	0.37*	10	20.25	220.00*	7850.00**	40	50.75**
	Roots	C	0.52	3.63	1.83	0.17	10	11.50	190.00	3200.00	40	53.00
		T	0.44	3.13	1.25**	0.42**	10	12.50	130.00	6200.00*	40	31.75

*, ** = Significantly different at 0.05 or 0.01 levels, respectively.

(continued)

TABLE 133. (CONTINUED)

Plants Species	Plant Part	Treat	Percent				PPM					
			Ca	K	N	P	Cd	Cu	Fe	Na	Pb	Zn
Wheat	Plants	C	0.43	2.73	1.04	0.06	10	9.50	300.00	430.00	40	47.50
		T	0.35	2.48	0.77	0.13	10	8.75	135.00	745.00	40	22.75**
	Heads	C	0.27	0.83	1.10	0.09	10	8.75	140.00	415.00	40	39.75
		T	0.26	0.88*	1.33	0.22*	10	8.25	275.00	277.50*	40	19.75**
	Seeds (100)	C	0.09	0.33	3.04	0.40	10	8.00	45.00	45.50	40	74.50
		T	0.09	0.36	2.74	0.45	10	8.00	40.00	24.00**	40	53.75**
Tomato	Fruit	C	0.13	4.10	3.19	0.33	10	24.50	115.00	305.00	40	40.25
		T	0.17	4.53	2.09**	0.56**	10	23.00	135.00	532.00	40	28.50*
Alfalfa	Hay	C	1.18	2.20	2.20	0.19	10	8.00	60.00	240.00	40	31.00
		T	2.50	1.20	2.52	0.12	10	8.00	90.00	380.00	40	31.00

*, ** = Significantly different at 0.05 or 0.01 levels, respectively.

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APPENDIX A

SOIL INVESTIGATION

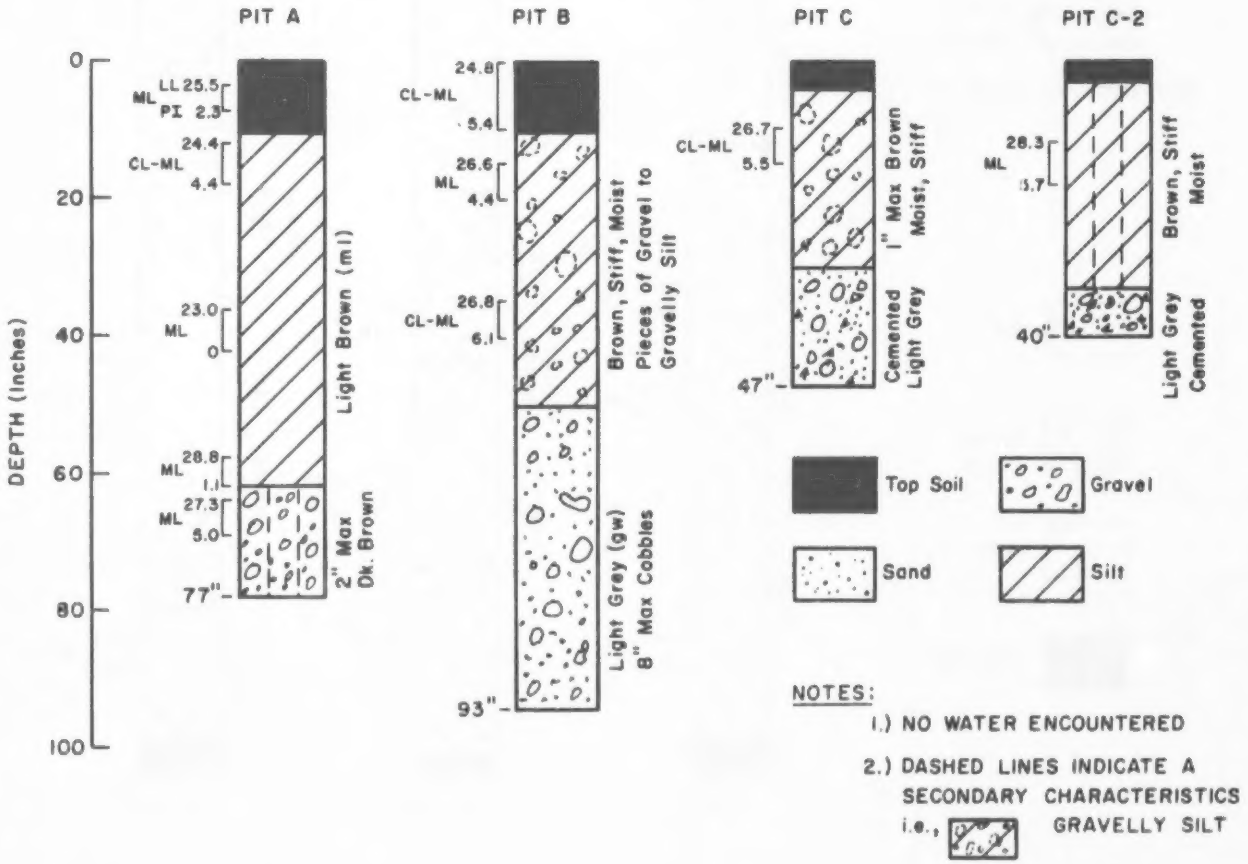
PIT A
PIT B
PIT C
PIT C-2
DEPTH (Inches)
0
20
40
60
80
100
ML LL 25.5 PI 2.3
CL-ML 24.4 4.4
ML 23.0 0
ML 28.8 1.1
ML 27.3 5.0
77"
Light Brown (ml)
2" Max Dk. Brown
CL-ML 24.8 5.4
ML 26.6 4.4
CL-ML 26.8 6.1
93"
Brown, Stiff, Moist Pieces of Gravel to Gravelly Silt
Light Grey (gw) 8" Max Cobbles
CL-ML 26.7 5.5
47"
1" Max Brown Moist, Stiff
Cemented Light Grey
ML 28.3 5.7
40"
Brown, Stiff Moist
Light Grey Cemented
Top Soil
Gravel
Sand
Silt
NOTES:
1.) NO WATER ENCOUNTERED
2.) DASHED LINES INDICATE A SECONDARY CHARACTERISTICS i.e., GRAVELLY SILT

Figure A-1. Test pit logs for the control site.

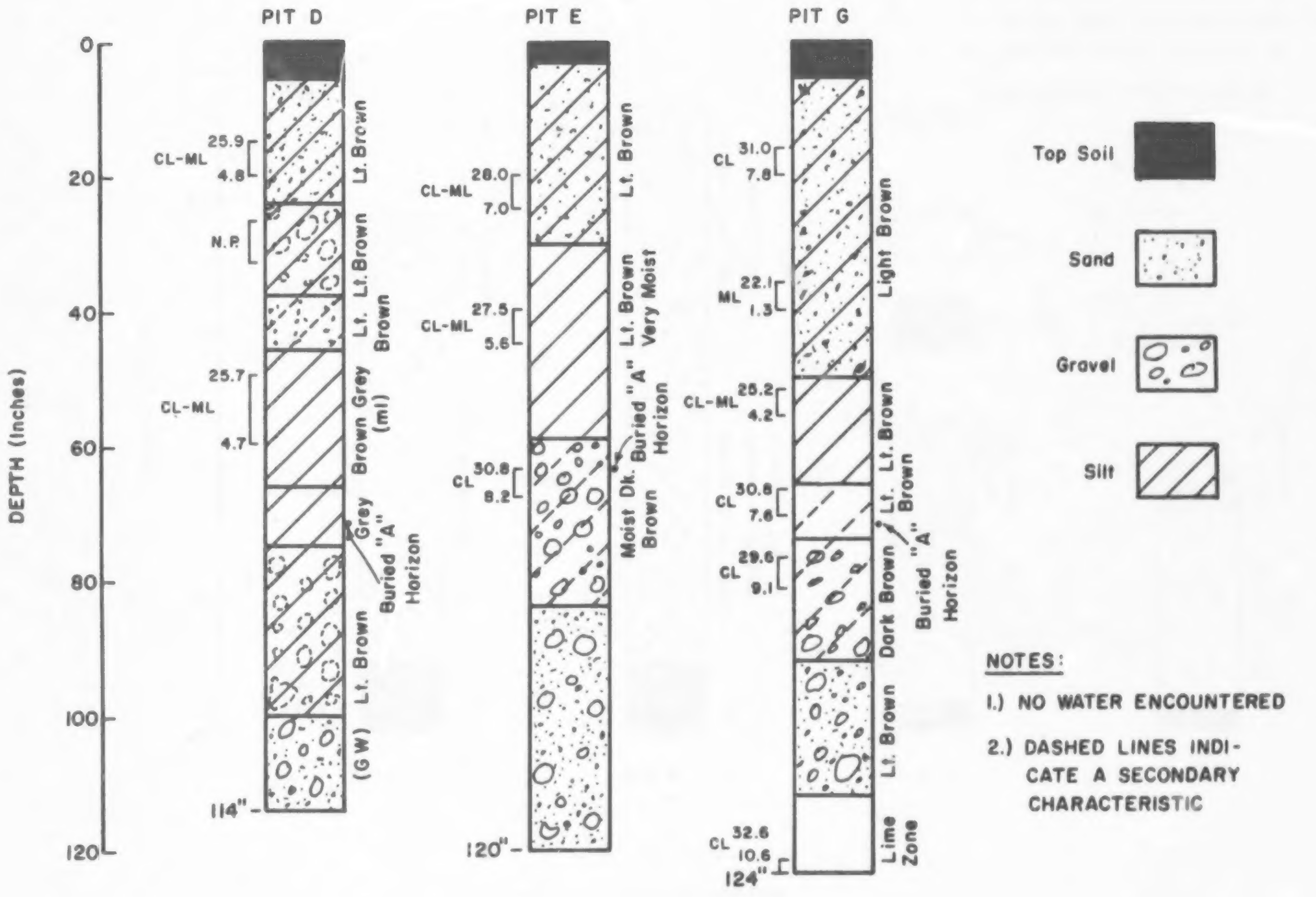
PIT D
PIT E
PIT G
DEPTH (Inches)
0
20
40
60
80
100
120
CL-ML 25.9 4.8
N.P.
CL-ML 25.7 4.7
114"
Lt. Brown
Lt. Lt. Brown
Lt. Brown
Brown Grey (ml)
Grey
Buried "A" Horizon
Lt. Brown
(GW)
CL-ML 28.0 7.0
CL-ML 27.5 5.6
CL 30.8 8.2
120"
Lt. Brown
Lt. Brown Very Moist
Buried "A" Horizon
Moist Dk. Brown
CL 31.0 7.8
ML 22.1 1.3
CL-ML 25.2 4.2
CL 30.8 7.6
CL 29.6 9.1
CL 32.6 10.6
124"
Light Brown
Lt. Lt. Brown
Buried "A" Brown Horizon
Dark Brown
Lt. Brown
Lime Zone
Top Soil
Sand
Gravel
Silt
NOTES:
1.) NO WATER ENCOUNTERED
2.) DASHED LINES INDICATE A SECONDARY CHARACTERISTIC

Figure A-2. Test pit logs for the treated site.

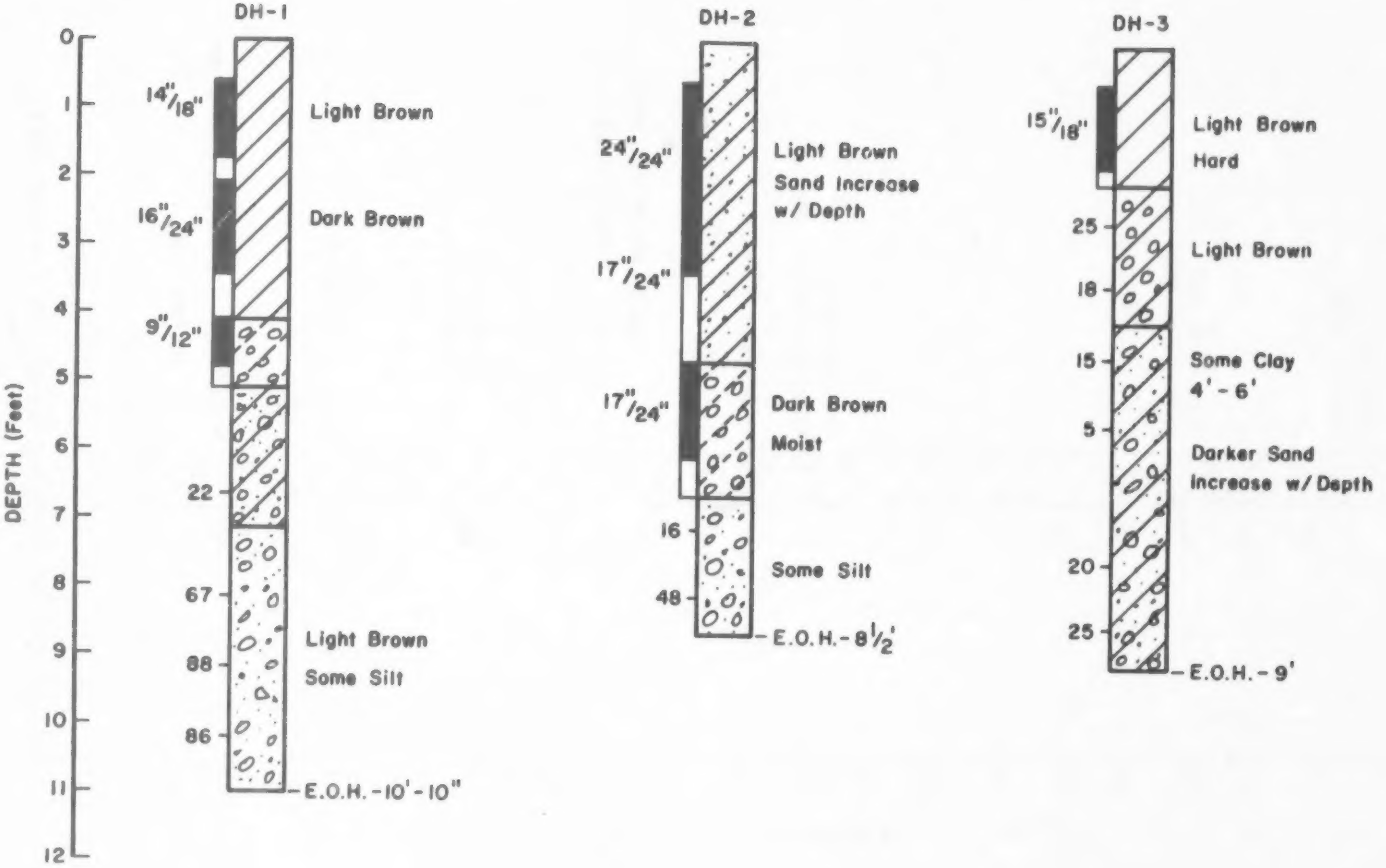
DH-1
DH-2
DH-3
DEPTH (Feet)
0
1
2
3
4
5
6
7
8
9
10
11
12
14"/18"
16"/24"
9"/12"
22
67
88
86
Light Brown
Dark Brown
Light Brown
Some Silt
E.O.H.-10'-10"
24"/24"
17"/24"
17"/24"
16
48
Light Brown
Sand Increase
w/ Depth
Dark Brown
Moist
Some Silt
E.O.H.-8½'
15"/18"
25
18
15
5
20
25
Light Brown
Hard
Light Brown
Some Clay
4'-6'
Darker Sand
Increase w/ Depth
E.O.H.-9'

Figure A-3. Boring logs of the treated site.

TABLE B-75. TOTAL COLIFORM (MF) CONCENTRATIONS DETERMINED DURING 1977

PARAMETER: TOTAL COLIFORM (MF)　　UNITS: COUNT/100 ML

DATE	STATION NUMBER 1	2	3	4	5	6	7	8	9	10
MAY 7, 1977	****			****					****	
MAY 14, 1977	.125E+03			.300E+03					****	
MAY 21, 1977	.490E+04			> .100E+04					****	
MAY 28, 1977	.495E+03			> .175E+03					****	
JUNE 7, 1977	.278E+04			.310E+04					****	
JUNE 14, 1977	.136E+04			> .573E+03					****	
JUNE 21, 1977	****			****					****	
JUNE 28, 1977	> .150E+04			****					****	
JULY 5, 1977	> .160E+05			> .933E+03					.100E+02	
JULY 12, 1977	.200E+05			.140E+04					.114E+02	
JULY 19, 1977	.629E+03			> .227E+04					.300E+02	
JULY 26, 1977	.827E+04			> .543E+04					****	
AUG. 2, 1977	.276E+05			.360E+04					> .150E+02	
AUG. 9, 1977	> .136E+04			> .132E+05					> .229E+02	
AUG. 16, 1977	.311E+04			.162E+04					.571E+02	
AUG. 23, 1977	.700E+03			.230E+03					****	
AUG. 30, 1977	> .508E+05			.162E+04					.200E+02	
SEP. 6, 1977	****			****					****	
SEP. 13, 1977	.500E+04			> .173E+04					****	
SEP. 20, 1977	.306E+05			< .541E+03					****	
SEP. 27, 1977	.133E+05			> .133E+04					****	
OCT. 5, 1977	.160E+05			****					****	
MAXIMUM	.508E+05			.132E+05					.571E+02	
MINIMUM	.125E+03			.175E+03					.100E+02	
GEOM. MEAN	.423E+04			> .126E+04					> .201E+02	
HARM. MEAN	.743E+04			> .167E+04					> .218E+02	
ARITH. MEAN	.106E+05			> .230E+04					> .238E+02	

**** = [illegible]

TABLE B-76. FECAL COLIFORM (MPN) CONCENTRATIONS DETERMINED DURING 1976

PARAMETER: FECAL COLIFORM (MPN)   TYPE: COUNT/100 ML

DATE	1	2	3	4	5	6	7	8	9	10
					STATION	NUMBER				
JUNE 17, 1976	****			.130E+04					.200E+01	
JUNE 23, 1976	.200E+05			.110E+04					.230E+02	
JULY 7, 1976	.350E+07			.110E+05					****	
JULY 14, 1976	<.200E+04			.130E+04					.200E+01	
JULY 22, 1976	.200E+04			.200E+03					<.200E+01	
JULY 29, 1976	<.200E+04			.500E+04					<.200E+01	
AUG. 5, 1976	.500E+03			.220E+05					.500E+01	
AUG. 12, 1976	<.200E+03			.220E+04					.500E+01	
AUG. 20, 1976	.130E+03			.500E+03					.200E+02	
SEP. 2, 1976	.130E+04			.500E+03					<.200E+01	
SEP. 10, 1976	<.200E+03			.200E+03					<.200E+01	
SEP. 17, 1976	.800E+03			<.200E+03					.500E+01	
SEP. 24, 1976	.200E+03			.200E+04					<.200E+01	
OCT. 1, 1976	.500E+05			.200E+03					<.200E+01	
OCT. 8, 1976	.230E+03			.230E+03					<.200E+01	
OCT. 15, 1976	.200E+03			.200E+03					<.200E+01	
OCT. 22, 1976	.200E+03			.200E+04					<.200E+01	
MAXIMUM	.350E+07			.220E+05					.230E+02	
MINIMUM	.130E+03			.200E+03					.200E+01	
GEOM. MEAN	<.130E+04			<.942E+03					<.319E+01	
EXP. MEAN	<.676E+04			<.153E+04					<.371E+01	
ARITH. MEAN	<.224E+06			.295E+04					<.500E+01	

**** NO DATA

TABLE B-77. FECAL COLIFORM (MPN) CONCENTRATIONS DETERMINED DURING 1977

PARAMETER: FECAL COLIFORM (MPN)   UNITS: COUNT/100 ML

DATE	STATION NUMBER 1	2	3	4	5	6	7	8	9	10
MAY 7, 1977	****			****					****	
MAY 14, 1977	****			****					****	
MAY 21, 1977	****			****					****	
MAY 28, 1977	****			****					****	
JUNE 7, 1977	****			****					****	
JUNE 14, 1977	****			****					****	
JUNE 21, 1977	****			****					****	
JUNE 28, 1977	****			****					****	
JULY 5, 1977	****			****					****	
JULY 12, 1977	****			****					****	
JULY 19, 1977	****			****					****	
JULY 26, 1977	****			****					****	
AUG. 2, 1977	****			****					****	
AUG. 9, 1977	****			****					****	
AUG. 16, 1977	****			****					****	
AUG. 23, 1977	****			****					****	
AUG. 30, 1977	****			****					****	
SEP. 6, 1977	****			****					****	
SEP. 13, 1977	****			****					****	
SEP. 20, 1977	****			****					****	
SEP. 27, 1977	****			****					****	
OCT. 5, 1977	****			****					****	
MAXIMUM	****			****					****	
MINIMUM	****			****					****	
GEOM. MEAN	****			****					****	
EXP. MEAN	****			****					****	
ARITH. MEAN	****			****					****	

**** = NO DATA

TABLE B-78. FECAL COLIFORM (MF) CONCENTRATIONS DETERMINED DURING 1976

PARAMETER: FECAL COLIFORM (MF   UNITS: COUNT/100 ML

DATE	STATION NUMBER 1	2	3	4	5	6	7	8	9	10
JUNE 17, 1976	****			.100E+01					.100E+01	
JUNE 23, 1976	.130E+04			< .100E+01					< .100E+01	
JULY 7, 1976	.200E+03			.240E+06					****	
JULY 15, 1976	< .100E+01			.250E+03					< .100E+01	
JULY 22, 1976	.970E+02			.300E+03					< .200E+01	
JULY 29, 1976	.230E+03			.180E+04					****	
AUG. 5, 1976	.210E+03			.640E+03					.500E+01	
AUG. 12, 1976	.330E+02			.790E+03					.200E+01	
AUG. 20, 1976	< .200E+01			.350E+03					.200E+01	
SEP. 2, 1976	.560E+02			.900E+02					< .200E+01	
SEP. 10, 1976	.200E+01			.120E+03					< .200E+01	
SEP. 17, 1976	.140E+03			.280E+03					< .200E+01	
SEP. 24, 1976	.160E+03			.120E+03					< .200E+01	
OCT. 1, 1976	****			.150E+03					< .200E+01	
OCT. 8, 1976	.140E+04			.190E+03					< .200E+01	
OCT. 15, 1976	.330E+02			.180E+03					.450E+01	
OCT. 22, 1976	.150E+03			.910E+03					< .200E+01	
MAXIMUM	.140E+04			.240E+06					.500E+01	
MINIMUM	.100E+01			.100E+01					.100E+01	
GEOM. MEAN	< .645E+02			< .225E+03					< .195E+01	
HARM. MEAN	< .168E+03			< .112E+04					< .204E+01	
ARITH. MEAN	< .268E+03			< .145E+05					< .217E+01	

**** = NO DATA

TABLE B-79. FECAL COLIFORM (MF) CONCENTRATIONS DETERMINED DURING 1977

PARAMETER: FECAL COLIFORM (MF)   UNITS: COUNTS/[illegible]

STATION NUMBER

DATE	1	2	3	4	5	6	7	8	9	10
MAY 7, 1977	****			****					****	
MAY 14, 1977	.192E+02			.200E+03					****	
MAY 21, 1977	.347E+02			.108E+03					****	
MAY 28, 1977	.400E+02			.200E+04					****	
JUNE 7, 1977	.507E+03			.160E+02					****	
JUNE 14, 1977	.400E+03			.300E+03					****	
JUNE 21, 1977	****			****					****	
JUNE 28, 1977	.224E+02			.907E+03					****	
JULY 5, 1977	****			.107E+04					.350E+00	
JULY 12, 1977	.104E+04			.947E+03					.330E+00	
JULY 19, 1977	.263E+03			.500E+04					.250E+00	
JULY 26, 1977	.380E+03			.907E+03					****	
AUG. 2, 1977	.380E+03			.507E+03					.330E+00	
AUG. 9, 1977	.250E+03			.480E+04					.330E+00	
AUG. 16, 1977	.488E+04			.160E+04					.330E+00	
AUG. 23, 1977	.133E+02			.124E+04					****	
AUG. 30, 1977	>.100E+05			.197E+04					.670E+00	
SEP. 6, 1977	****			****					****	
SEP. 13, 1977	.667E+02			.740E+03					****	
SEP. 20, 1977	.101E+04			.460E+03					****	
SEP. 27, 1977	.920E+03			.237E+04					****	
OCT. 5, 1977	.209E+03			.853E+03					****	
MAXIMUM	.100E+05			.500E+04					.670E+00	
MINIMUM	.133E+02			.160E+02					.250E+00	
GEOM. MEAN	.244E+03			.762E+03					.354E+00	
[illegible] MEAN	>.522E+03			.113E+04					.361E+00	
ARITH. MEA	>.114E+04			.137E+04					.370E+00	

**** = [illegible]

TABLE B-80. FECAL STREPTOCOCCUS (M-ENT) CONCENTRATIONS DETERMINED DURING 1976

[illegible] STREPTOCOCCUS (M-ENT,) UNITS, COUNTS/ [illegible]

DATE	STATION NUMBER 1	2	3	4	5	6	7	8	9	10
JUNE 17, 1976	****			.250E+04					.100E+01	
JUNE 23, 1976	.150E+04			.100E+01					.400E+02	
JULY 7, 1976	.520E+05			.200E+04					****	
JULY 15, 1976	.910E+03			.330E+03					.100E+01	
JULY 22, 1976	.770E+03			.230E+03					.200E+01	
JULY 29, 1976	****			.120E+04					.200E+01	
AUG. 5, 1976	.950E+03			.180E+04					.870E+01	
AUG. 12, 1976	.120E+03			.910E+03					.220E+02	
AUG. 20, 1976	.190E+05			.100E+04					.200E+01	
SEP. 2, 1976	.400E+01			.970E+03					.350E+04	
SEP. 10, 1976	.200E+01			.170E+04					.700E+01	
SEP. 17, 1976	.720E+04			.220E+04					.300E+01	
SEP. 24, 1976	.100E+03			.240E+04					.100E+02	
OCT. 1, 1976	****			.600E+03					.200E+01	
OCT. 8, 1976	.270E+05			.470E+03					.200E+01	
OCT. 15, 1976	.360E+04			.110E+04					.250E+01	
OCT. 22, 1976	.770E+04			.140E+04					.200E+01	
MAXIMUM	.520E+05			.250E+04					.350E+04	
MINIMUM	.600E+01			.100E+01					.100E+01	
GEOM. MEAN	.953E+03			.708E+03					.559E+01	
EXP. MEAN	.756E+04			.146E+04					.135E+02	
ARITH. MEAN	.863E+04			.122E+04					.225E+03	

**** = NO DATA

TABLE B-81. FECAL STREPTOCOCCUS (M-ENT) CONCENTRATIONS DETERMINED DURING 1977

PARAMETER: FECAL STREPTOCOCCUS (M-ENT) UNITS: COUNT/ [illegible] ML

DATE	STATION NUMBER 1	2	3	4	5	6	7	8	9	10
MAY 7, 1977	****			****					****	
MAY 14, 1977	****			****					****	
MAY 21, 1977	****			****					****	
MAY 28, 1977	****			****					****	
JUNE 7, 1977	****			****					****	
JUNE 14, 1977	****			****					****	
JUNE 21, 1977	****			****					****	
JUNE 28, 1977	****			****					****	
JULY 5, 1977	****			****					****	
JULY 12, 1977	****			****					****	
JULY 19, 1977	****			****					****	
JULY 26, 1977	****			****					****	
AUG. 2, 1977	****			****					****	
AUG. 9, 1977	****			****					****	
AUG. 16, 1977	****			****					****	
AUG. 23, 1977	****			****					****	
AUG. 30, 1977	****			****					****	
SEP. 6, 1977	****			****					****	
SEP. 13, 1977	****			****					****	
SEP. 20, 1977	****			****					****	
SEP. 27, 1977	****			****					****	
OCT. 5, 1977	****			****					****	
MAXIMUM	****			****					****	
MINIMUM	****			****					****	
GEOM. MEAN	****			****					****	
EXP. MEAN	****			****					****	
ARITH. MEAN	****			****					****	

**** = NO DATA

TABLE B-82. FECAL STREPTOCOCCUS (KF) CONCENTRATIONS DETERMINED DURING 1976

PARAMETER: FECAL STREPTOCOCCUS (KF)   UNITS: COUNT/[illegible]

DATE	STATION NUMBER 1	2	3	4	5	6	7	8	9	10
JUNE 17, 1976	****			.100E+01					.100E+01	
JUNE 23, 1976	.150E+04			.100E+01					.270E+02	
JULY 7, 1976	.600E+05			.400E+03					****	
JULY 15, 1976	.570E+03			.250E+03					.750E+02	
JULY 22, 1976	.390E+03			.260E+03					.200E+01	
JULY 29, 1976	.290E+03			.570E+03					.200E+01	
AUG. 5, 1976	.260E+03			.960E+03					.650E+01	
AUG. 12, 1976	.960E+02			.650E+03					.240E+02	
AUG. [illegible], 1976	.360E+04			.120E+04					.200E+01	
SEP. 2, 1976	.500E+01			.930E+03					.240E+04	
SEP. 10, 1976	.200E+01			.250E+04					.200E+01	
SEP. 17, 1976	.120E+04			.280E+04					.300E+01	
SEP. 24, 1976	.600E+02			.800E+04					.500E+01	
OCT. 1, 1976	****			****					****	
OCT. 8, 1976	****			****					****	
OCT. 15, 1976	****			****					****	
OCT. 22, 1976	****			****					****	
MAXIMUM	.600E+05			.800E+04					.240E+04	
MINIMUM	.200E+01			.100E+01					.100E+01	
GEOM. MEAN	.291E+03			.331E+03					.868E+01	
EXP. MEAN	.156E+04			.172E+04					.249E+02	
ARITH. MEAN	.566E+04			.142E+04					.212E+03	

**** = NO DATA

TABLE B-83. FECAL STREPTOCOCCUS (KF) CONCENTRATIONS DETERMINED DURING 1977

PARAMETER: FECAL STREPTOCOCCUS (KF) UNITS: [illegible] ML

DATE	STATION NUMBER 1	2	3	4	5	6	7	8	9	10
MAY 7, 1977	****			****					****	
MAY 14, 1977	.418E+02			.220E+03					****	
MAY 21, 1977	.118E+04			.184E+03					****	
MAY 28, 1977	.108E+04			.136E+04					****	
JUNE 7, 1977	.486E+02			.709E+03					****	
JUNE 14, 1977	.300E+03			.254E+03					****	
JUNE 21, 1977	.156E+04			.753E+02					****	
JUNE 28, 1977	.100E+02			.320E+03					****	
JULY 5, 1977	.288E+04			.920E+03					.200E+01	
JULY 12, 1977	.168E+03			.912E+03					.400E+00	
JULY 19, 1977	.840E+03			.250E+04					.800E+00	
JULY 26, 1977	.370E+04			.633E+04					****	
AUG. 2, 1977	.125E+05			.606E+04					****	
AUG. 9, 1977	.440E+03			.960E+04					.660E+00	
AUG. 16, 1977	.778E+02			.121E+04					.267E+01	
AUG. 23, 1977	.667E+02			.214E+04					****	
AUG. 30, 1977	.780E+04			.360E+04					.833E+01	
SEP. 6, 1977	****			****					****	
SEP. 13, 1977	.124E+04			.377E+04					****	
SEP. 20, 1977	.340E+03			.140E+04					****	
SEP. 27, 1977	.314E+03			.507E+04					****	
OCT. 4, 1977	.282E+02			.115E+05					****	
MAXIMUM	.125E+05			.115E+05					.833E+01	
MINIMUM	.100E+02			.753E+02					.400E+00	
GEOM. MEAN	< .417E+03			.137E+04					.145E+01	
EXP. MEAN	< .918E+03			.213E+04					.190E+01	
ARITH. MEAN	.171E+04			.291E+04					< .240E+01	

**** = [illegible]

APPENDIX C

STATISTICAL COMPARISON OF THE 1976 WATER QUALITY DATA WITH THE 1977 WATER QUALITY DATA

TABLE C-1. STATISTICAL COMPARISON OF 1976 WITH 1977 DATA

Station Numbers 1, 2, 3, 4, 5, 7, 8, 9, 11

F-test

H: $\sigma_{76} = \sigma_{77}$ a = accept R = reject

	1			2			3			4			5			7			8			9			11		
	0.95	0.975	0.995	0.95	0.975	0.995	0.95	0.975	0.995	0.95	0.975	0.995	0.95	0.975	0.995	0.95	0.975	0.995	0.95	0.975	0.995	0.95	0.975	0.995	0.95	0.975	0.995
TC-MPN	a	a	a							a	a	a										a	a	a	a	a	a
TC-MF	a	a	a							R	R	R										a	a	a	a	a	a
FC-MPN	-	-	-							-	-	-										-	-	-	-	-	-
FC-MF	R	R	R							R	R	R										R	R	R	R	R	R
FS-MF-KF	R	R	R							a	a	a										R	R	R	R	R	R
Alk	R	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a
Ca	R	R	R	R	R	R	R	R	R	R	R	R	a	a	a	a	a	a	a	a	a	R	R	R	R	R	R
Cl	a	a	a	R	R	a	R	R	a	R	R	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a
Hard	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	a	a	a	R	R	R	R	R	R	R	R	R
NH_3	a	a	a	a	a	a	a	a	a	R	R	R	a	a	a	a	a	a	R	a	a	a	a	a	a	a	a
NO_2	R	a	a	a	a	a	R	R	a	a	a	a	a	a	a	a	a	a	a	a	a	R	R	R	R	R	R
NO_3	R	a	a	R	a	a	R	R	R	R	R	R	a	a	a	a	a	a	R	a	a	a	a	a	a	a	a
TKN	R	R	a	R	R	R	R	R	a	R	R	R	a	a	a	a	a	a	R	R	R	R	R	R	R	R	R
TP	a	a	a	a	a	a	a	a	a	R	a	a	a	a	a	a	a	a	a	a	a	R	a	a	R	a	a
TSP	R	R	a	a	a	a	R	a	a	R	a	a	a	a	a	a	a	a	a	a	a	-	-	-	-	-	-
PO_4	R	R	R	R	R	a	R	R	R	R	R	R	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a
TDS	a	a	a	a	a	a	a	a	a	a	a	a	R	R	a	-	-	-	R	R	a	R	R	R	R	R	R
TSS	R	a	a	R	R	R	R	R	R	R	R	R	R	R	R	a	a	a	a	a	a	R	R	R	R	R	R
VSS	a	a	a	R	R	R	R	R	R	R	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a
Cond.	a	a	a	R	a	a	a	a	a	R	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a
SO_4	a	a	a	a	a	a	a	a	a	R	a	a	R	R	a	a	a	a	a	a	a	a	a	a	a	a	a
Temp																											
DO																											
pH																											
BOD_5	a	a	a	R	R	R	a	a	a	R	R	R	a	a	a	-	-	-	a	a	a	R	a	a	R	a	a
COD	a	a	a	R	a	a	R	a	a	R	R	R	a	a	a	R	R	a	R	R	a	R	R	R	R	R	R
Al	R	a	a	a	a	a	a	a	a	R	a	a	R	a	a	-	-	-	-	-	-	R	R	a	R	R	a
As																											
Cd	a	a	a	a	a	a	R	a	a	a	a	a	R	R	a	-	-	-	-	-	-	R	R	R	R	R	R
Cr	R	R	R	R	R	R	-	-	-	a	a	a	R	R	R	-	-	-	-	-	-	a	a	a	a	a	a
Cu	a	a	a	a	a	a	a	a	a	a	a	a	R	R	R	-	-	-	-	-	-	R	a	a	R	a	a
Fe	R	a	a	R	R	a	-	-	-	R	a	a	R	R	R	-	-	-	-	-	-	R	R	R	R	R	R
Pb																											
Mg	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	-	-	-	-	-	-
Mn	-	-	-	a	a	a	R	R	a	a	a	a	a	a	a	-	-	-	-	-	-	R	R	R	R	R	R
Hg	R	R	R	R	R	R	R	R	a	R	R	R	R	R	R	-	-	-	R	R	R	a	a	a	a	a	a
Ni																											
K	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a
Ag	-	-	-	a	a	a	-	-	-	-	-	-	a	a	a	-	-	-	-	-	-	R	R	R	R	R	R
Na	a	a	a	a	a	a	R	a	a	a	a	a	a	a	a	a	a	a	a	a	a	R	R	R	R	R	R
Zn	a	a	a	a	a	a	R	a	a	a	a	a	R	R	R	-	-	-	-	-	-	a	a	a	a	a	a

TABLE C-1. CONTINUED

Station Numbers 1, 2, 3, 4, 5, 7, 8, 9, 11
Weighted "t"-test

H: $\mu_{76} = \mu_{77}$ a = accept R = reject

	1			2			3			4			5			7			8			9			11		
	0.95	0.975	0.995	0.95	0.975	0.995	0.95	0.975	0.995	0.95	0.975	0.995	0.95	0.975	0.995	0.95	0.975	0.995	0.95	0.975	0.995	0.95	0.975	0.995	0.95	0.975	0.995
TC-MPN	a	a	a							a	a	a										R	a	a	R	a	a
TC-MF	a	a	a							a	a	a										a	a	a	a	a	a
FC-MPN	-	-	-							-	-	-										-	-	-	-	-	-
FC-MF	a	a	a							a	a	a										R	R	R	R	R	R
FS	a	a	a							a	a	a										a	a	a	a	a	a
Alk	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a
Ca	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a
Cl	a	a	a	a	a	a	a	a	a	R	R	a	R	a	a	a	a	a	R	a	a	a	a	a	a	a	a
Hard	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a
NH_3	R	R	R	R	R	R	R	R	a	a	a	a	R	R	a	a	a	a	R	R	R	a	a	a	a	a	a
NO_2	a	a	a	a	a	a	R	R	a	a	a	a	R	R	a	R	R	a	a	a	a	R	R	a	R	R	a
NO_3	a	a	a	R	R	a	R	R	a	R	R	a	R	R	a	a	a	a	R	R	R	a	a	a	a	a	a
TKN	R	R	R	R	R	R	R	R	R	R	a	a	R	R	a	a	a	a	R	R	R	a	a	a	a	a	a
TP	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a
TSP	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a
PO_4	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a
TDS	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a
TSS	R	R	a	a	a	a	a	a	a	R	R	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a
VSS	R	a	a	R	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a
Cond	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	R	R	a	R	R	a
SO_4	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a
Temp																											
DO																											
pH																											
BOD_5	R	R	R	R	R	R	a	a	a	a	a	a	a	a	a	-	-	-	a	a	a	a	a	a	a	a	a
COD	R	R	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a
Al	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a
As																											
Cd	R	R	R	R	R	R	R	R	R	R	R	a	R	R	R	-	-	-	-	-	-	R	R	R	R	R	R
Cr	a	a	a	a	a	a	-	-	-	a	a	a	a	a	a	-	-	-	-	-	-	a	a	a	a	a	a
Cu	a	a	a	a	a	a	R	a	a	a	a	a	a	a	a	-	-	-	-	-	-	R	R	a	R	R	a
Fe	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	-	-	-	-	-	-	R	a	a	R	a	a
Pb																											
Mg	R	R	a	R	R	R	R	R	R	R	R	R	R	R	R	R	R	a	R	R	R	-	-	-	-	-	-
Mn	-	-	-	a	a	a	a	a	a	a	a	a	R	a	a	-	-	-	-	-	-	a	a	a	a	a	a
Hg	R	a	a	R	R	a	R	a	a	R	R	R	a	a	a	-	-	-	R	a	a	a	a	a	a	a	a
Ni																											
K	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	a	a	a	R	R	R	R	R	R	R	R	R
Ag	-	-	-	a	a	a	-	-	-	-	-	-	R	R	R	-	-	-	-	-	-	R	a	a	R	a	a
Na	R	R	R	R	R	R	R	R	R	R	R	a	R	R	R	a	a	a	R	R	R	a	a	a	a	a	a
Zn	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	-	-	-	-	-	-	a	a	a	a	a	a

TABLE C-1. CONTINUED

Station Numbers 1, 2, 3, 4, 5, 7, 8, 9, 11
"t"-test

H: $\mu_{76} = \mu_{77}$ a = accept R = reject

	1			2			3			4			5			7			8			9			11		
	0.95	0.975	0.995	0.95	0.975	0.995	0.95	0.975	0.995	0.95	0.975	0.995	0.95	0.975	0.995	0.95	0.975	0.995	0.95	0.975	0.995	0.95	0.975	0.995	0.95	0.975	0.995
TC-MPN	a	a	a							a	a	a										R	R	R	R	R	R
TC-MF	a	a	a							a	a	a										a	a	a	a	a	a
FC-MPN	-	-	-							-	-	-										-	-	-	-	-	-
FC-MF	a	a	a							a	a	a										R	R	R	R	R	R
FS	a	a	a							a	a	a										a	a	a	a	a	a
Alk	a	a	a	R	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a
Ca	a	a	a	a	a	a	R	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a
Cl	a	a	a	a	a	a	R	R	a	R	R	a	R	R	a	a	a	a	R	a	a	a	a	a	a	a	a
Hard	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	R	R	a	R	R	a
NH_3	R	R	R	R	R	R	R	R	a	a	a	a	R	R	a	a	a	a	R	R	a	a	a	a	a	a	a
NO_2	a	a	a	a	a	a	R	R	a	a	a	a	R	R	a	R	R	a	a	a	a	R	R	R	R	R	R
NO_3	a	a	a	R	R	a	R	R	a	R	R	a	R	R	a	a	a	a	R	R	R	a	a	a	a	a	a
TKN	R	R	R	R	R	R	R	R	R	a	a	a	R	R	a	a	a	a	R	R	a	a	a	a	a	a	a
TP	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a
TSP	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a
PO_4	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a
TDS	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a
TSS	R	R	R	a	a	a	R	a	a	R	a	a	R	R	a	a	a	a	a	a	a	a	a	a	a	a	a
VSS	R	a	a	R	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a
Cond	R	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	R	R	a	R	R	a
SO_4	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a
Temp																											
DO																											
pH																											
BOD_5	R	R	R	R	R	R	a	a	a	a	a	a	a	a	a	R	a	a	a	a	a	a	a	a	a	a	a
COD	R	R	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a
Al	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	-	-	-	a	a	a	a	a	a	a	a	a
As																											
Cd	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	-	-	-	R	R	R	R	R	R	R	R	R
Cr	R	a	a	R	a	a	R	R	a	R	a	a	a	a	a	-	-	-	a	a	a	R	a	a	R	a	a
Cu	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	-	-	-	a	a	a	R	R	a	R	R	a
Fe	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	-	-	-	a	a	a	R	R	a	R	R	a
Pb	R	R	R	R	R	R	-	-	-	a	a	a	R	R	R	-	-	-	R	R	R	R	R	R	R	R	R
Mg	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	a	R	R	a
Mn	R	R	R	a	a	a	a	a	a	a	a	a	R	R	a	-	-	-	-	-	-	a	a	a	a	a	a
Hg	R	R	a	R	R	R	R	a	a	R	R	R	a	a	a	-	-	-	R	R	a	a	a	a	a	a	a
Ni																											
K	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	a	a	a	R	R	R	R	R	R	R	R	R
Ag	R	R	R	a	a	a	R	R	R	R	R	R	R	R	R	-	-	-	R	R	a	R	R	R	R	R	R
Na	R	R	R	R	R	R	R	R	R	R	R	a	R	R	R	a	a	a	R	R	R	a	a	a	a	a	a
Zn	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	R	R	R	a	a	a	a	a	a

TABLE C-2. STATISTICAL COMPARISON OF MEANS AT STATION NUMBERS 1 AND 4

Paired observations

H: $\mu_1 = \mu_4$

a = accept R = reject

	76 & 77			76			77		
	0.95	0.975	0.995	0.95	0.975	0.995	0.95	0.975	0.995
TC-MPN	a	a	a	a	a	a	a	a	a
TC-MF	a	a	a	a	a	a	R	R	a
TC-MPN	a	a	a	a	a	a	–	–	–
TC-MF	a	a	a	a	a	a	a	a	a
FS	a	a	a	a	a	a	a	a	a
Alk	R	a	a	a	a	a	R	a	a
Ca	a	a	a	a	a	a	a	a	a
Cl	a	a	a	a	a	a	a	a	a
Hard	a	a	a	a	a	a	a	a	a
NH_3	a	a	a	a	a	a	a	a	a
NO_2	R	R	R	R	R	R	R	R	R
NO_3	R	R	R	R	R	R	R	R	R
TKN	R	R	R	R	R	R	a	a	a
TP	R	R	R	R	R	a	R	R	R
TSP	a	a	a	a	a	a	a	a	a
PO_4	a	a	a	R	a	a	a	a	a
TDS	a	a	a	a	a	a	a	a	a
TSS	a	a	a	R	R	a	R	R	a
VSS	R	a	a	R	R	a	a	a	a
Cond	a	a	a	a	a	a	a	a	a
SO_4	a	a	a	a	a	a	a	a	a
Temp	–	–	–	–	–	–	–	–	–
DO	–	–	–	–	–	–	–	–	–
pH	–	–	–	–	–	–	–	–	–
BOD_5	R	R	R	R	R	R	a	a	a
COD	R	R	R	R	R	R	a	a	a
Al	a	a	a	a	a	a	a	a	a
As	a	a	a	–	–	–	a	a	a
Cd	a	a	a	a	a	a	a	a	a
Cr	a	a	a	a	a	a	a	a	a
Cu	R	a	a	a	a	a	R	a	a
Fe	a	a	a	a	a	a	a	a	a
Pb	a	a	a	a	a	a	a	a	a
Mg	a	a	a	a	a	a	a	a	a
Mn	a	a	a	a	a	a	a	a	a
Hg	a	a	a	a	a	a	a	a	a
Ni	a	a	a	–	–	–	a	a	a
K	R	a	a	R	R	a	a	a	a
Ag	a	a	a	a	a	a	a	a	a
Na	a	a	a	a	a	a	a	a	a
Zn	R	R	R	a	a	a	R	R	R

TABLE C-3. STATISTICAL COMPARISON OF MEANS AT STATION NUMBERS 2 AND 8

Paired observations

H: $\mu_2 = \mu_8$

a = accept R = reject

	76 & 77			76			77		
	0.95	0.975	0.995	0.95	0.975	0.995	0.95	0.975	0.995
TC-MPN									
TC-MF									
FC-MPN									
FC-MF									
FS-1									
Alk	R	R	R	R	R	R	a	a	a
Ca	a	a	a	a	a	a	a	a	a
Cl	a	a	a	a	a	a	a	a	a
Hard	a	a	a	R	a	a	a	a	a
NH_3	a	a	a	a	a	a	a	a	a
NO_2	a	a	a	a	a	a	a	a	a
NO_3	R	R	a	a	a	a	R	R	R
TKN	R	R	a	R	a	a	a	a	a
TP	a	a	a	a	a	a	R	a	a
TSP	a	a	a	a	a	a	a	a	a
PO_4	a	a	a	R	R	a	a	a	a
TDS	a	a	a	a	a	a	a	a	a
TSS	R	a	a	a	a	a	R	a	a
VSS	R	a	a	a	a	a	R	a	a
Cond	a	a	a	a	a	a	a	a	a
SO_4	a	a	a	a	a	a	a	a	a
Temp	–	–	–	–	–	–	–	–	–
DO	–	–	–	–	–	–	–	–	–
pH	–	–	–	–	–	–	–	–	–
BOD_5	a	a	a	R	R	a	R	R	a
COD	a	a	a	a	a	a	a	a	a
Al	a	a	a	–	–	–	a	a	a
As	a	a	a	–	–	–	a	a	a
Cd	a	a	a	–	–	–	a	a	a
Cr	a	a	a	–	–	–	a	a	a
Cu	a	a	a	–	–	–	a	a	a
Fe	a	a	a	–	–	–	a	a	a
Pb	a	a	a	–	–	–	a	a	a
Mg	R	R	a	R	R	a	a	a	a
Mn	a	a	a	–	–	–	a	a	a
Hg	a	a	a	a	a	a	a	a	a
Ni	a	a	a	–	–	–	a	a	a
K	R	R	a	a	a	a	a	a	a
Ag	a	a	a	–	–	–	a	a	a
Na	a	a	a	a	a	a	a	a	a
Zn	a	a	a	–	–	–	a	a	a

TABLE C-4. STATISTICAL COMPARISON OF MEANS AT STATION NUMBERS 4 AND 7

Paired observations

H: $\mu_4 = \mu_7$

a = accept R = reject

	76 & 77			76			77		
	0.95	0.975	0.995	0.95	0.975	0.995	0.95	0.975	0.995
TC-MPN									
TC-MF									
FC-MPN									
FC-MF									
FS									
Alk	a	a	a	a	a	a	a	a	a
Ca	a	a	a	a	a	a	a	a	a
Cl	a	a	a	a	a	a	a	a	a
Hard	R	R	a	a	a	a	a	a	a
NH_3	R	a	a	a	a	a	a	a	a
NO_2	R	R	a	R	a	a	a	a	a
NO_3	a	a	a	a	a	a	a	a	a
TKN	a	a	a	a	a	a	a	a	a
TP	a	a	a	a	a	a	a	a	a
TSP	a	a	a	a	a	a	R	R	R
PO_4	a	a	a	a	a	a	a	a	a
TDS	a	a	a	R	a	a	–	–	–
TSS	a	a	a	a	a	a	a	a	a
VSS	a	a	a	a	a	a	a	a	a
Cond	a	a	a	a	a	a	R	a	a
SO_4	a	a	a	a	a	a	a	a	a
Temp	–	–	–	–	–	–	–	–	–
DO	–	–	–	–	–	–	–	–	–
pH	–	–	–	–	–	–	–	–	–
BOD_5	a	a	a	a	a	a	–	–	–
COD	R	a	a	a	a	a	a	a	a
Al	a	a	a	–	–	–	a	a	a
As	a	a	a	–	–	–	a	a	a
Cd	a	a	a	–	–	–	a	a	a
Cr	a	a	a	–	–	–	a	a	a
Cu	–	–	–	–	–	–	–	–	–
Fe	a	a	a	–	–	–	a	a	a
Pb	a	a	a	–	–	–	a	a	a
Mg	a	a	a	a	a	a	a	a	a
Mn	a	a	a	–	–	–	a	a	a
Hg	a	a	a	–	–	–	a	a	a
Ni	a	a	a	–	–	–	a	a	a
K	R	a	a	a	a	a	a	a	a
Ag	a	a	a	–	–	–	a	a	a
Na	a	a	a	a	a	a	a	a	a
Zn	a	a	a	–	–	–	a	a	a

TABLE C-5. STATISTICAL COMPARISON OF MEANS AT STATION NUMBERS 4 AND 8

Paired observations

H: $\mu_4 = \mu_8$

a = accept R = reject

	76 & 77			76			77		
	0.95	0.975	0.995	0.95	0.975	0.995	0.95	0.975	0.995
TC-MPN									
TC-MF									
FC-MPN									
FC-MF									
FS									
Alk	a	a	a	a	a	a	a	a	a
Ca	a	a	a	a	a	a	R	a	a
Cl	R	a	a	a	a	a	a	a	a
Hard	a	a	a	a	a	a	a	a	a
NH_3	a	a	a	R	R	a	a	a	a
NO_2	R	R	a	R	R	R	a	a	a
NO_3	R	R	R	a	a	a	R	R	R
TKN	a	a	a	a	a	a	a	a	a
TP	a	a	a	a	a	a	a	a	a
TSP	a	a	a	a	a	a	a	a	a
PO_4	a	a	a	a	a	a	a	a	a
TDS	a	a	a	a	a	a	a	a	a
TSS	R	R	R	R	a	a	R	R	R
VSS	R	R	R	a	a	a	R	R	a
Cond	a	a	a	a	a	a	a	a	a
SO_4	a	a	a	R	a	a	a	a	a
Temp	–	–	–	–	–	–	–	–	–
DO	–	–	–	–	–	–	–	–	–
pH	–	–	–	–	–	–	–	–	–
BOD_5	a	a	a	a	a	a	a	a	a
COD	a	a	a	a	a	a	a	a	a
Al	a	a	a	–	–	–	a	a	a
As	a	a	a	–	–	–	a	a	a
Cd	a	a	a	–	–	–	a	a	a
Cr	a	a	a	–	–	–	a	a	a
Cu	a	a	a	–	–	–	a	a	a
Fe	a	a	a	–	–	–	a	a	a
Pb	a	a	a	–	–	–	a	a	a
Mg	a	a	a	a	a	a	a	a	a
Mn	a	a	a	–	–	–	a	a	a
Hg	a	a	a	a	a	a	a	a	a
Ni	a	a	a	–	–	–	a	a	a
K	a	a	a	a	a	a	a	a	a
Ag	a	a	a	–	–	–	a	a	a
Na	a	a	a	a	a	a	a	a	a
Zn	R	a	a	a	a	a	R	R	R

TABLE C-6. STATISTICAL COMPARISON OF MEANS AT STATION NUMBERS 4 AND 11

Paired observations
H: $\mu_4 = \mu_{11}$
a = accept R = reject

	76 & 77			76			77		
	0.95	0.975	0.995	0.95	0.975	0.995	0.95	0.975	0.995
TC-MPN	R	R	R	R	R	R	R	R	R
TC-MF	R	R	a	R	a	a	R	a	a
FC-MPN	R	R	R	R	R	R	–	–	–
FC-MF	R	R	R	R	R	R	R	R	a
FS	R	R	a	R	a	a	R	a	a
Alk	R	R	R	R	R	R	R	R	R
Ca	R	R	R	R	R	R	R	a	a
Cl	R	R	R	R	R	R	R	R	R
Hard	R	R	R	R	R	R	a	a	a
NH_3	R	R	R	R	R	R	R	R	a
NO_2	R	R	R	R	R	R	R	R	R
NO_3	R	R	R	R	R	R	R	R	R
TKN	R	R	R	R	R	R	R	R	R
TP	R	R	R	R	R	R	R	R	R
TSP	R	R	R	R	R	R	–	–	–
PO_4	R	R	R	R	R	R	a	a	a
TDS	R	R	R	R	R	R	a	a	a
TSS	R	R	R	R	R	R	R	R	R
VSS	R	R	R	R	R	R	R	R	R
Cond	R	R	R	R	R	R	R	R	R
SO_4	R	R	R	R	R	R	R	R	a
Temp	–	–	–	–	–	–	–	–	–
DO	–	–	–	–	–	–	–	–	–
pH	–	–	–	–	–	–	–	–	–
BOD_5	R	R	R	R	R	R	R	R	R
COD	R	R	R	R	R	R	R	R	R
Al	–	–	–	–	–	–	–	–	–
As	–	–	–	–	–	–	–	–	–
Cd	a	a	a	–	–	–	a	a	a
Cr	a	a	a	–	–	–	a	a	a
Cu	a	a	a	–	–	–	a	a	a
Fe	a	a	a	–	–	–	a	a	a
Pb	a	a	a	–	–	–	a	a	a
Mg	R	R	a	R	R	a	–	–	–
Mn	a	a	a	–	–	–	a	a	a
Hg	a	a	a	a	a	a	a	a	a
Ni	a	a	a	–	–	–	a	a	a
K	R	R	R	R	R	R	R	R	R
Ag	a	a	a	–	–	–	–	–	–
Na	R	R	R	R	R	R	R	R	R
Zn	a	a	a	–	–	–	a	a	a

TABLE C-7. STATISTICAL COMPARISON OF MEANS AT STATION NUMBERS 8 AND 11

Paired observations
H: $\mu_8 = \mu_{11}$
a = accept R = reject

	76 & 77			76			77		
	0.95	0.975	0.995	0.95	0.975	0.995	0.95	0.975	0.995
TC-MPN									
TC-MF									
FC-MPN									
FC-MF									
FS									
Alk	R	R	R	R	R	R	R	R	R
Ca	R	R	R	R	R	R	R	R	a
Cl	R	R	R	R	R	R	R	R	a
Hard	R	R	R	R	R	R	a	a	a
NH_3	R	R	R	R	R	R	R	R	a
NO_2	R	R	R	R	R	R	R	R	R
NO_3	R	R	R	R	R	R	R	R	R
TKN	R	R	R	R	R	R	R	R	R
TP	R	R	R	R	R	R	R	R	R
TSP	R	R	R	R	R	R	–	–	–
PO_4	R	R	R	R	R	R	R	R	a
TDS	a	a	a	R	R	a	a	a	a
TSS	R	R	R	R	R	R	R	R	R
VSS	R	R	R	R	R	R	R	R	R
Cond	R	R	R	R	R	R	R	R	R
SO_4	R	R	R	R	R	R	R	R	a
Temp	–	–	–	–	–	–	–	–	–
DO	–	–	–	–	–	–	–	–	–
pH	–	–	–	–	–	–	–	–	–
BOD_5	R	R	R	R	R	R	R	R	R
COD	R	R	R	R	R	R	R	R	a
Al	–	–	–	–	–	–	–	–	–
As	–	–	–	–	–	–	–	–	–
Cd	a	a	a	–	–	–	a	a	a
Cr	a	a	a	–	–	–	a	a	a
Cu	a	a	a	–	–	–	a	a	a
Fe	a	a	a	–	–	–	a	a	a
Pb	a	a	a	–	–	–	a	a	a
Mg	R	R	a	R	R	a	–	–	–
Mn	a	a	a	–	–	–	a	a	a
Hg	a	a	a	a	a	a	a	a	a
Ni	a	a	a	–	–	–	a	a	a
K	R	R	R	R	R	R	R	R	R
Ag	a	a	a	–	–	–	–	–	–
Na	R	R	R	R	R	R	R	R	R
Zn	a	a	a	–	–	–	a	a	a

TABLE C-8. STATISTICAL COMPARISON OF VARIANCES AT STATION NUMBERS 1 AND 4

Assuming independent sets of data
Observations are not paired
F-test
$\sigma_1 = \sigma_4$
a = accept R = reject

	76 & 77			76			77		
	0.95	0.975	0.995	0.95	0.975	0.995	0.95	0.975	0.995
Al	a	a	a	a	a	a	a	a	a
As	–	–	–	–	–	–	–	–	–
Cd	a	a	a	a	a	a	a	a	a
Cr	R	R	R	a	a	a	a	a	a
Cu	R	R	R	a	a	a	R	R	R
Fe	a	a	a	a	a	a	a	a	a
Pb	R	a	a	–	–	–	–	–	–
Mg	a	a	a	a	a	a	a	a	a
Mn	R	R	R	–	–	–	R	R	R
Hg	R	R	R	R	R	R	R	R	a
Ni	a	a	a	–	–	–	a	a	a
K	a	a	a	a	a	a	a	a	a
Ag	a	a	a	–	–	–	–	–	–
Na	a	a	a	a	a	a	a	a	a
Zn	R	R	R	a	a	a	R	R	R

TABLE C-9. STATISTICAL COMPARISON OF VARIANCES AT STATION NUMBERS 2 AND 8

Assuming independent sets of data
Observations are not paired
F-test
$\sigma_2 = \sigma_8$
a = accept R = reject

	76 & 77			76			77		
	0.95	0.975	0.995	0.95	0.975	0.995	0.95	0.975	0.995
Al	a	a	a	–	–	–	a	a	a
As	a	a	a	–	–	–	a	a	a
Cd	a	a	a	–	–	–	a	a	a
Cr	R	R	R	–	–	–	a	a	a
Cu	R	R	R	–	–	–	R	R	R
Fe	R	R	a	–	–	–	a	a	a
Pb	a	a	a	–	–	–	–	–	–
Mg	a	a	a	a	a	a	a	a	a
Mn	a	a	a	–	–	–	a	a	a
Hg	a	a	a	a	a	a	R	a	a
Ni	a	a	a	–	–	–	a	a	a
K	a	a	a	a	a	a	a	a	a
Ag	a	a	a	–	–	–	a	a	a
Na	a	a	a	a	a	a	a	a	a
Zn	a	a	a	–	–	–	a	a	a

TABLE C-10. STATISTICAL COMPARISON OF VARIANCES AT STATION NUMBERS 4 AND 7

Assuming independent sets of data
Observations are not paired
F-test
$\sigma_4 = \sigma_7$
a = accepted R = rejected

	76 & 77			76			77		
	0.95	0.975	0.995	0.95	0.975	0.995	0.95	0.975	0.995
Al	–	–	–	–	–	–	–	–	–
As	a	a	a	–	–	–	a	a	a
Cd	–	–	–	–	–	–	–	–	–
Cr	–	–	–	–	–	–	–	–	–
Cu	–	–	–	–	–	–	–	–	–
Fe	a	a	a	–	–	–	a	a	a
Pb	–	–	–	–	–	–	–	–	–
Mg	a	a	a	a	a	a	a	a	a
Mn	a	a	a	–	–	–	a	a	a
Hg	a	a	a	–	–	–	–	–	–
Ni	–	–	–	–	–	–	–	–	–
K	R	R	R	R	R	a	R	R	a
Ag	–	–	–	–	–	–	–	–	–
Na	a	a	a	a	a	a	a	a	a
Zn	a	a	a	–	–	–	a	a	a

TABLE C-11. STATISTICAL COMPARISON OF VARIANCES AT STATION NUMBERS 4 AND 8

Assuming independent sets of data
Observations are not paired
F-test
$\sigma_4 = \sigma_8$
a = accepted R = rejected

	76 & 77			76			77		
	0.95	0.975	0.995	0.95	0.975	0.995	0.95	0.975	0.995
Al	a	a	a	–	–	–	a	a	a
As	a	a	a	–	–	–	a	a	a
Cd	a	a	a	–	–	–	a	a	a
Cr	a	a	a	–	–	–	a	a	a
Cu	R	R	R	–	–	–	R	R	R
Fe	a	a	a	–	–	–	a	a	a
Pb	R	R	R	–	–	–	–	–	–
Mg	a	a	a	a	a	a	a	a	a
Mn	R	R	a	–	–	–	R	R	a
Hg	R	R	R	R	R	R	R	R	R
Ni	a	a	a	–	–	–	a	a	a
K	a	a	a	a	a	a	a	a	a
Ag	a	a	a	–	–	–	a	a	a
Na	a	a	a	a	a	a	a	a	a
Zn	a	a	a	–	–	–	a	a	a

TABLE C-12 STATISTICAL COMPARISON OF VARIANCES AT STATION NUMBERS 4 AND 11.

Assuming independent sets of data
Observations are not paired
F-test
$\sigma_4 = \sigma_{11}$
a = accept R = reject

	76 & 77			76			77		
	0.95	0.975	0.995	0.95	0.975	0.995	0.95	0.975	0.995
Al	a	a	a	a	a	a	a	a	a
As	R	R	a	–	–	–	R	R	a
Cd	a	a	a	a	a	a	a	a	a
Cr	a	a	a	a	a	a	a	a	a
Cu	a	a	a	a	a	a	a	a	a
Fe	a	a	a	a	a	a	a	a	a
Pb	R	a	a	–	–	–	–	–	–
Mg	R	R	a	a	a	a	–	–	–
Mn	a	a	a	a	a	a	R	R	R
Hg	R	R	R	R	R	R	R	R	R
Ni	a	a	a	–	–	–	a	a	a
K	R	R	R	R	R	R	R	R	R
Ag	a	a	a	–	–	–	a	a	a
Na	R	R	R	R	R	R	R	R	R
Zn	R	R	a	a	a	a	R	R	R

TABLE C-13 STATISTICAL COMPARISON OF VARIANCES AT STATION NUMBERS 8 AND 11.

Assuming independent sets of data
Observations are not paired
F-test
$\sigma_8 = \sigma_{11}$
a = accept R = reject

	76 & 77			76			77		
	0.95	0.975	0.995	0.95	0.975	0.995	0.95	0.975	0.995
Al	a	a	a	–	–	–	a	a	a
As	R	R	a	–	–	–	R	R	a
Cd	a	a	a	–	–	–	a	a	a
Cr	a	a	a	–	–	–	a	a	a
Cu	R	R	R	–	–	–	R	R	R
Fe	R	R	a	–	–	–	a	a	a
Pb	a	a	a	–	–	–	–	–	–
Mg	R	R	a	a	a	a	–	–	–
Mn	a	a	a	–	–	–	R	R	a
Hg	a	a	a	a	a	a	R	R	R
Ni	a	a	a	–	–	–	a	a	a
K	R	R	R	R	R	R	R	R	R
Ag	a	a	a	–	–	–	a	a	a
Na	R	R	R	R	R	R	R	R	R
Zn	a	a	a	–	–	–	R	R	a

TABLE C-14 STATISTICAL COMPARISON OF MEANS AT STATION NUMBERS 1 AND 4.

Assuming independent sets of data
Observations are not paired
"t"-test
$\mu_1 = \mu_4$
a = accept R = reject

	76 & 77			76			77		
	0.95	0.975	0.995	0.95	0.975	0.995	0.95	0.975	0.995
Al	a	a	a	a	a	a	a	a	a
As	–	–	–	–	–	–	–	–	–
Cd	a	a	a	a	a	a	a	a	a
Cr	a	a	a	a	a	a	a	a	a
Cu	a	a	a	a	a	a	a	a	a
Fe	a	a	a	a	a	a	a	a	a
Pb	a	a	a	–	–	–	–	–	–
Mg	a	a	a	a	a	a	a	a	a
Mn	a	a	a	–	–	–	a	a	a
Hg	a	a	a	a	a	a	a	a	a
Ni	a	a	a	–	–	–	a	a	a
K	a	a	a	a	a	a	a	a	a
Ag	a	a	a	–	–	–	–	–	–
Na	a	a	a	a	a	a	a	a	a
Zn	a	a	a	a	a	a	a	a	a

TABLE C-15 STATISTICAL COMPARISON OF MEANS AT STATION NUMBERS 2 AND 8.

Assuming independent sets of data
Observations are not paired
"t"-test
$\mu_2 = \mu_8$
a = accept R = reject

	76 & 77			76			77		
	0.95	0.975	0.995	0.95	0.975	0.995	0.95	0.975	0.995
Al	a	a	a	–	–	–	a	a	a
As	a	a	a	–	–	–	a	a	a
Cd	a	a	a	–	–	–	a	a	a
Cr	a	a	a	–	–	–	a	a	a
Cu	a	a	a	–	–	–	a	a	a
Fe	a	a	a	–	–	–	a	a	a
Pb	a	a	a	–	–	–	–	–	–
Mg	a	a	a	a	a	a	a	a	a
Mn	a	a	a	–	–	–	a	a	a
Hg	a	a	a	a	a	a	a	a	a
Ni	a	a	a	–	–	–	a	a	a
K	a	a	a	a	a	a	a	a	a
Ag	a	a	a	–	–	–	a	a	a
Na	a	a	a	a	a	a	a	a	a
Zn	a	a	a	–	–	–	a	a	a

TABLE C-16 STATISTICAL COMPARISON OF MEANS AT STATION NUMBERS 4 AND 7.

Assuming independent sets of data
Observations are not paired
"t"-test
$\mu_4 = \mu_8$
a = accept R = reject

	76 & 77			76			77		
	0.95	0.975	0.995	0.95	0.975	0.995	0.95	0.975	0.995
Al	–	–	–	–	–	–	–	–	–
As	a	a	a	–	–	–	a	a	a
Cd	–	–	–	–	–	–	–	–	–
Cr	–	–	–	–	–	–	–	–	–
Cu	–	–	–	–	–	–	–	–	–
Fe	a	a	a	–	–	–	a	a	a
Pb	–	–	–	–	–	–	–	–	–
Mg	a	a	a	a	a	a	a	a	a
Mn	a	a	a	–	–	–	a	a	a
Hg	a	a	a	–	–	–	–	–	–
Ni	–	–	–	–	–	–	–	–	–
K	a	a	a	a	a	a	R	a	a
Ag	–	–	–	–	–	–	–	–	–
Na	a	a	a	a	a	a	a	a	a
Zn	a	a	a	–	–	–	a	a	a

TABLE C-17 STATISTICAL COMPARISON OF MEANS AT STATION NUMBERS 4 AND 8.

Assuming independent sets of data
Observations are not paired
"t"-test
$\mu_4 = \mu_8$
a = accept R = reject

	76 & 77			76			77		
	0.95	0.975	0.995	0.95	0.975	0.995	0.95	0.975	0.995
Al	a	a	a	–	–	–	a	a	a
As	a	a	a	–	–	–	a	a	a
Cd	a	a	a	–	–	–	a	a	a
Cr	a	a	a	–	–	–	a	a	a
Cu	a	a	a	–	–	–	a	a	a
Fe	a	a	a	–	–	–	a	a	a
Pb	a	a	a	–	–	–	–	–	–
Mg	a	a	a	a	a	a	a	a	a
Mn	a	a	a	–	–	–	a	a	a
Hg	a	a	a	a	a	a	a	a	a
Ni	a	a	a	–	–	–	a	a	a
K	a	a	a	a	a	a	a	a	a
Ag	a	a	a	–	–	–	a	a	a
Na	a	a	a	a	a	a	a	a	a
Zn	a	a	a	–	–	–	a	a	a

TABLE C-18 STATISTICAL COMPARISON OF MEANS AT STATION NUMBERS 4 AND 11.

Assuming independent sets of data
Observations are not paired
"t"-test
$\mu_4 = \mu_{11}$
a = accept R = reject

	76 & 77			76			77		
	0.95	0.975	0.995	0.95	0.975	0.995	0.95	0.975	0.995
Al	a	a	a	a	a	a	a	a	a
As	R	R	a	–	–	–	R	R	a
Cd	a	a	a	a	a	a	a	a	a
Cr	a	a	a	a	a	a	a	a	a
Cu	a	a	a	R	a	a	a	a	a
Fe	a	a	a	a	a	a	a	a	a
Pb	a	a	a	–	–	–	–	–	–
Mg	a	a	a	a	a	a	–	–	–
Mn	a	a	a	a	a	a	a	a	a
Hg	a	a	a	a	a	a	a	a	a
Ni	a	a	a	–	–	–	a	a	a
K	R	R	R	R	R	R	R	R	R
Hg	a	a	a	–	–	–	a	a	a
Na	R	R	R	R	R	R	R	R	R
Zn	a	a	a	a	a	a	a	a	a

TABLE C-19 STATISTICAL COMPARISON OF MEANS AT STATION NUMBERS 8 AND 11.

Assuming independent sets of data
Observations are not paired
"t"-test
$\mu_8 = \mu_{11}$
a = accept R = reject

	76 & 77			76			77		
	0.95	0.975	0.995	0.95	0.975	0.995	0.95	0.975	0.995
Al	a	a	a	–	–	–	a	a	a
As	R	R	a	–	–	–	R	R	a
Cd	a	a	a	–	–	–	a	a	a
Cr	a	a	a	–	–	–	a	a	a
Cu	a	a	a	–	–	–	a	a	a
Fe	a	a	a	–	–	–	a	a	a
Pb	a	a	a	–	–	–	–	–	–
Mg	a	a	a	a	a	a	–	–	–
Mn	a	a	a	–	–	–	a	a	a
Hg	a	a	a	a	a	a	a	a	a
Ni	a	a	a	–	–	–	a	a	a
K	R	R	R	R	R	R	R	R	R
Ag	a	a	a	–	–	–	a	a	a
Na	R	R	R	R	R	R	R	R	R
Zn	a	a	a	–	–	–	a	a	a

TABLE C-20 STATISTICAL COMPARISON OF MEANS AT STATION NUMBERS 1 AND 4.

Assuming independent sets of data
Observations are not paired
Weighted "t"-test
$\mu_1 = \mu_4$
a = accept R = reject

	76 & 77			76			77		
	0.95	0.975	0.995	0.95	0.975	0.995	0.95	0.975	0.995
Al	a	a	a	a	a	a	a	a	a
As	-	-	-	-	-	-	-	-	-
Cd	a	a	a	a	a	a	a	a	a
Cr	a	a	a	a	a	a	a	a	a
Cu	R	a	a	a	a	a	a	a	a
Fe	a	a	a	a	a	a	a	a	a
Pb	a	a	a	-	-	-	-	-	-
Mg	a	a	a	a	a	a	a	a	a
Mn	a	a	a	-	-	-	a	a	a
Hg	a	a	a	a	a	a	a	a	a
Ni	a	a	a	-	-	-	a	a	a
K	a	a	a	R	a	a	a	a	a
Ag	a	a	a	-	-	-	-	-	-
Na	a	a	a	a	a	a	a	a	a
Zn	R	R	R	a	a	a	R	R	R

TABLE C-21 STATISTICAL COMPARISON OF MEANS AT STATION NUMBERS 2 AND 8.

Assuming independent sets of data
Observations are not paired
Weighted "t"-test
$\mu_2 = \mu_8$
a = accept R = reject

	76 & 77			76			77		
	0.95	0.975	0.995	0.95	0.975	0.995	0.95	0.975	0.995
Al	a	a	a	-	-	-	a	a	a
As	a	a	a	-	-	-	a	a	a
Cd	a	a	a	-	-	-	a	a	a
Cr	a	a	a	-	-	-	a	a	a
Cu	a	a	a	-	-	-	a	a	a
Fe	a	a	a	-	-	-	a	a	a
Pb	a	a	a	-	-	-	-	-	-
Mg	a	a	a	R	a	a	a	a	a
Mn	a	a	a	-	-	-	a	a	a
Hg	a	a	a	a	a	a	a	a	a
Ni	a	a	a	-	-	-	a	a	a
K	a	a	a	a	a	a	a	a	a
Ag	a	a	a	-	-	-	a	a	a
Na	a	a	a	a	a	a	a	a	a
Zn	a	a	a	-	-	-	a	a	a

TABLE C-22 STATISTICAL COMPARISON OF MEANS AT STATION NUMBERS 4 AND 7.

Assuming independent sets of data
Observations are not paired
Weighted "t" test
$\mu_4 = \mu_7$
a = accept R = reject

	76 & 77			76			77		
	0.95	0.975	0.995	0.95	0.975	0.995	0.95	0.975	0.995
Al	-	-	-	-	-	-	-	-	-
As	a	a	a	-	-	-	a	a	a
Cd	-	-	-	-	-	-	-	-	-
Cr	-	-	-	-	-	-	-	-	-
Cu	-	-	-	-	-	-	-	-	-
Fe	a	a	a	-	-	-	a	a	a
Pb	-	-	-	-	-	-	-	-	-
Mg	a	a	a	a	a	a	a	a	a
Mn	a	a	a	-	-	-	a	a	a
Hg	a	a	a	-	-	-	-	-	-
Ni	-	-	-	-	-	-	-	-	-
K	a	a	a	a	a	a	a	a	a
Ag	-	-	-	-	-	-	-	-	-
Na	a	a	a	a	a	a	a	a	a
Zn	a	a	a	-	-	-	a	a	a

TABLE C-23 STATISTICAL COMPARISON OF MEANS AT STATION NUMBERS 4 AND 8.

Assuming independent sets of data
Observations are not paired
Weighted "t" test
$\mu_4 = \mu_8$
a = accept R = reject

	76 & 77			76			77		
	0.95	0.975	0.995	0.95	0.975	0.995	0.95	0.975	0.995
Al	a	a	a	-	-	-	a	a	a
As	a	a	a	-	-	-	a	a	a
Cd	a	a	a	-	-	-	a	a	a
Cr	a	a	a	-	-	-	a	a	a
Cu	a	a	a	-	-	-	a	a	a
Fe	a	a	a	-	-	-	a	a	a
Pb	a	a	a	-	-	-	-	-	-
Mg	a	a	a	a	a	a	a	a	a
Mn	a	a	a	-	-	-	a	a	a
Hg	a	a	a	a	a	a	a	a	a
Ni	a	a	a	-	-	-	a	a	a
K	a	a	a	a	a	a	a	a	a
Ag	a	a	a	-	-	-	a	a	a
Na	a	a	a	a	a	a	a	a	a
Zn	a	a	a	-	-	-	R	R	a

TABLE C-24 STATISTICAL COMPARISON OF MEANS AT STATION NUMBERS 4 AND 11.

Assuming independent sets of data
Observations are not paired
Weighted "t" test
$\mu_4 = \mu_{11}$
a = accept R = reject

	76 & 77			76			77		
	0.95	0.975	0.995	0.95	0.975	0.995	0.95	0.975	0.997
Al	a	a	a	a	a	a	a	a	a
As	R	R	a	–	–	–	R	R	a
Cd	a	a	a	a	a	a	a	a	a
Cr	a	a	a	a	a	a	a	a	a
Cu	a	a	a	a	a	a	a	a	a
Fe	a	a	a	a	a	a	a	a	a
Pb	a	a	a	–	–	–	–	–	–
Mg	a	a	a	R	R	a	–	–	–
Mn	a	a	a	a	a	a	a	a	a
Hg	R	R	a	a	a	a	a	a	a
Ni	a	a	a	–	–	–	a	a	a
K	R	R	R	R	R	R	R	R	R
Ag	a	a	a	–	–	–	a	a	a
Na	R	R	R	R	R	R	R	R	R
Zn	a	a	a	a	a	a	a	a	a

TABLE C-25 STATISTICAL COMPARISON OF MEANS AT STATION NUMBERS 8 AND 11.

Assuming independent sets of data
Observations are not paired
Weighted "t" test
$\mu_8 = \mu_{11}$
a = accept R = reject

	76 & 77			76			77		
	0.95	0.975	0.995	0.95	0.975	0.995	0.95	0.975	0.995
Al	a	a	a	–	–	–	a	a	a
As	R	R	a	–	–	–	R	R	a
Cd	R	a	a	–	–	–	a	a	a
Cr	a	a	a	–	–	–	a	a	a
Cu	a	a	a	–	–	–	a	a	a
Fe	a	a	a	–	–	–	a	a	a
Pb	a	a	a	–	–	–	–	–	–
Mg	a	a	a	R	R	a	–	–	–
Mn	a	a	a	–	–	–	a	a	a
Hg	a	a	a	a	a	a	a	a	a
Ni	a	a	a	–	–	–	a	a	a
K	R	R	R	R	R	R	R	R	R
Ag	a	a	a	–	–	–	a	a	a
Na	R	R	R	R	R	R	R	R	R
Zn	a	a	a	–	–	–	a	a	a